SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1903.

GENERAL PHYSICS.

1130. *Turbidimeter.* **C. Anthony, Jr.** (Eng. Record, 47. p. 106, Jan. 24, 1903. Paper read before the New England Waterworks Association, Sept., 1902.)—This instrument for measuring the turbidity of water depends upon a photometric method. The amount of light absorbed by a given thickness of water is measured. The instrument consists of a couple of parallel tubes of standard length (50 cm.), one of which contains the water to be examined. Light reaches the eye after passing, part through the water and part through a Nicol prism. An equality of the two parts is obtained by rotating a second Nicol forming the eyepiece. The instrument is graduated. J. W. P.

1131. *Gallenkamp's Measurements with Adhesion Plates.* **G. Quincke.** (Ann. d. Physik, 10. 2. pp. 453–456, Jan. 27, 1903.)—The author criticises the numbers obtained by Gallenkamp [see Abstract No. 379 (1903)], which he compares with values arrived at by himself in 1877. T. H. P.

1132. *Automatic Sprengel Pump.* **W. Donle.** (Ann. d. Physik, 10. 2. pp. 315–325, Jan. 27, 1903.)—The author describes an improved form of his air pump made by R. Ebermayer, of Münich. The new form embodies some features of Kahlbaum's pumps [see Abstracts Nos. 1 and 1655 (1902)], and produces a good vacuum almost as rapidly as the latter, with a charge of only 1 kg. instead of 10 kg. of mercury. The mercury is replenished from a vessel connected with a water-jet pump; the fall tube has a diameter of 3 mm.; other tubes are at least 6 mm. in diameter. H. B.

1133. *Elasticity of Nickel-Steels.* **C. E. Guillaume.** (Comptes Rendus, 136. pp. 498–500, Feb. 23, 1903.)—Observations are made at different temperatures upon a chronometer provided with a spiral of the alloy to be studied, acting as balance spring. Knowing the dilatation of the spring and the rate of the chronometer, the formula connecting thermal variation of modulus of elasticity with temperature is obtained. A table of values of the elastic coefficients for different alloys is given. J. W. P.

1134. *Changes in Nickel-Steels.* **C. E. Guillaume.** (Comptes Rendus, 136. pp. 356–358, Feb. 9, 1903.)—Bars of the alloys are kept for long periods at steady temperatures, and the variations of length, due to the after-effect of a previous heating, are observed. Alloys of different kinds are considered, and their suitability for standards of length commented upon. The distinction (previously pointed out) between reversible and irreversible alloys is again remarked in these experiments. J. W. P.

1135. *Elasticity of Copper and Steel at Low Temperatures.* **J. R. Benton.** (Phys. Rev. 16. pp. 17–27, Jan., 1903.)—Young's modulus and the rigidity modulus are determined for these metals at the liquid air temperature. For copper the moduli are respectively $Y_{24} \times 1{\cdot}177$ and $R_{21} \times 1{\cdot}063$, where Y_{24} is Young's modulus at 24° and R_{21} the rigidity modulus at 21°. For steel the values are $Y_{21} \times 1{\cdot}085$ and $R_{20} \times 1{\cdot}072$. Poisson's ratio is found to be increased at the low temperature. Comparison with results for high temperatures by Pisati and Wertheim is made. The Young's modulus is determined by stretching, the rigidity by statical torsion. Description of the apparatus employed is given. J. W. P.

1136. *Elasticity and Magnetism.* **R. Arnoux.** (Soc. Franc. Phys., Séances, 1. pp. 20–21, 1903.)—A band of vulcanised caoutchouc, on being submitted to increasing tensions, behaves similarly to virgin iron under magnetisation. Curves of extension and force are shown to illustrate this.

J. W. P.

1137. *Elasticity Coefficients of Substances of Low-melting Points.* **C. Schaefer.** (Ann. d. Physik, 9. 5. pp. 1124–1127, Dec., 1902.)—On account of the importance of the elasticity number μ in the theory of elasticity, the author has determined this constant for selenium, for Wood's alloy, and for Lipowitz's alloy by the method suggested by Cornu and worked out by Straubel [see Abstract No. 1620 (1899)]. The results were as follows: For Se (M.P. 125°), $\mu = 0{\cdot}447$; Wood's alloy (M.P. 65°), $\mu = 0{\cdot}489$; Lipowitz's alloy (M.P. 75°), $\mu = 0{\cdot}452$. In addition to these measurements at the ordinary temperature, further determinations with selenium were made at other temperatures, in such a way that an observation was made with the selenium at 80° and then further observations at intervals of ten minutes during cooling. Thus it was found—

At 80° C. (circa)	$\mu = 0{\cdot}490$	time $t =$ 0 min.
	$\mu = 0{\cdot}480$	$t = 10$ „
	$\mu = 0{\cdot}480$	$t = 20$ „
	$\mu = 0{\cdot}448$	$t = 30$ „
At 20° C.	$\mu = 0{\cdot}445$	$t = 40$ „

These results support the view that the value of μ reaches its upper limiting value, $\frac{1}{2}$, *at the melting-point*, as suggested by Stokes and Bock. D. H. J.

1138. *Dielectric Cohesion of Gases.* **E. Bouty.** (Comptes Rendus, 136. pp. 40–41, Jan. 5, 1903.)—The critical field necessary in order to overcome the dielectric cohesion of a gas is the sum of two terms; the one (which preponderates at a pressure of some cm. of Hg) tends, as the pressure increases, towards a linear function of the pressure; the other (which preponderates at very low pressures) increases very rapidly as the pressure falls, being inversely as the pressure or even, within a certain interval, inversely as the square of the pressure. With gas-layers of over 6 cm. under a potential-gradient of 2,500 volts per cm., the visible light is an index of the passage of electricity through the gas, at least as delicate as the measurement of capacity is. At high pressures the critical value of the field is independent of the thickness of the gas-layer; but at low pressures it is not the value of the field, but the total difference of potential across the gas-layer which is constant, and the critical field varies inversely as the thickness of the gas-layer. The former of these gives a constant, the ratio between the first term of the field and the pressure, which is characteristic for each gas, and measures the dielectric cohesion in it; the latter measures the resistance to rupture of dielectric equilibrium at the bounding surface, either between the walls and the gas or between the free gas and the gas condensed on the walls. Considering the difference of potential necessary to produce a discharge as being the same as that necessary for the production of a continuous current through the gas, we have an analogy between a gas and a liquid between electrodes; in the latter case there is an electrodic drop of potential and also a slope of potential in the electrolyte. A. D.

1139. *Cellular Structure in Amorphous Bodies.* **G. Cartaud.** (Comptes Rendus, 136. pp. 51–53, Jan. 5, 1903.)—As the author has previously shown, the free surfaces of certain metals, if rapidly cooled from the fused condition, exhibit under the microscope a cellular structure. With zinc and some other metals it is found that each cell possesses a circular nucleus in relief. Similar nuclei are shown by collodion containing castor oil and by glass which has been heated in a gas-flame. Since in some other cases this cellular structure has been referred to the development of gases or vapours, it appears probable that this is also the cause of the phenomenon in the case of metals and glass. T. H. P.

1140. *Surface Tension Errors in Hydrometry.* **A. G. Levy.** (Roy. Soc., Proc. 71. pp. 171–176, Jan., 1903. From the Laboratory of Pathological Chemistry, University College, London.)—The paper gives a description of the class of error to which surface tension gives rise, from four hydrometers of different sizes immersed in a mixture of chloroform and benzol. A comparison of experiment and theory leads to the conclusion that the error expressed in scale-units varies directly as the radius of the stem, and inversely as the total weight of the instrument. The bearings of the results upon Hammerschlag's method for finding the specific gravity of the blood is pointed out. J. W. P.

1141. *Physical Constants of Camphor Nitrile; Reaction between Oximes and Thionyl Chloride.* **B. Pawlewski.** (Acad. Sci. Cracovie, Bull. 1. pp. 8–9, Jan., 1903.)—Though ketoximes as a rule are not affected by thionyl chloride, the oxime from camphor is exceptional and yields the corresponding nitrile. The physical constants of camphor nitrile are as follows: boiling point, 228·2°; density—$d_0 = 0·9227$, $d_{20} = 0·9113$, $d_{40} = 0·8995$, $d_4^{20} = 0·9098$; coefficient of cubic dilatation—$a_{0-20°} = 0·000625$, $a_{20-40°} = 0·000664$; specific heat between 16° and 40° = 0·476; specific refraction, $(n-1)/d = 0·5158$; molecular refraction = 76·85; rotivity, $[\alpha]_D^{20} = 4·02°$. D. H. J.

1142. *Explanation of Forces at a Distance.* **E. de Camas.** (Revue Scientif. 18. pp. 744–751, Dec. 13, 1902.)—The attempt is made to show that, by means of a simple hypothesis, a general explanation can be given for cosmic, physical, chemical, and even vital phenomena. The conception is that the ether surrounding material bodies is cut up by nodal and internodal regions caused by the reflection on those bodies of vibrations arriving from outer space. If the reflection occurs without change of sign, there is an internode at the material surface, as at the end of an open pipe ; whereas if there is change in sign, the surface is a node. Now suppose a material atom placed in this region thus cut up by nodes and internodes into stationary waves ; it tends to a node, as do sand particles in Chladni's plates ; but there are certain bodies, such as the concave sphere (which is composed of six spherical surfaces concave outwards), which tend to proceed to an internode. The positive ion is a concave sphere whose surface is a node ; it tends to move towards an internode. The negative ion is a convex sphere whose surface is an internode, and it tends to set towards a node. A material ion is formed by the combination of the positive and negative kinds ; it has a nodal surface and tends to a node. The amount of the forces between positive and negative ions is shown by analysis to be proportional to the number acting, and inversely as the square of the distance apart. On these lines the author deals with nebulæ and planetary problems, with spectrum lines and with primordial life. P. E. S.

1143. *Deformation of an Isotropic Elastic Sphere.* **G. Lauricella.** (N. Cimento, 5. pp. 5–26, Jan., 1903.)—The author refers to a former paper (Annali di Matematica, T. 6 S. 3), in which he applied a new method to the problem of the deformation of an elastic sphere when the superficial displacements are given. The same method can be applied to the case where, instead of the displacements, the tensions on the bounding surface are given. Almansi has shown (Accad. Lincei, S. 2. T. 47) that the solution can be made to depend on three auxiliary functions, and these are easily found by the method employed by the writer in the former and the present paper. The results hold also for the case of an infinite space external to a spherical surface. It is impossible to give in an abstract the mathematical calculations. The fundamental equations are as follows : Given an isotropic elastic body S, σ its surface, let ξ, η, ζ be the components of displacement, T_{xx}, T_{yy}, T_{zz}, and T_{xy}, T_{xz}, T_{yz} the six components of internal tension. Then, in the absence of external forces, if $-F_x$, $-F_y$, $-F_z$ be the components of superficial tension, we have within S—

$$\partial T_{xx}/\partial x + \partial T_{xy}/\partial y + \partial T_{xz}/\partial z = 0, \text{ \&c. } \ldots\ldots = 0,$$

and on the surface σ, if n be the normal measured inwards—

$$T_{xx}\frac{\partial x}{\partial n} + T_{xy}\frac{\partial y}{\partial n} + T_{xz}\frac{\partial z}{\partial n} = -F_x, \quad T_{xy}\frac{\partial x}{\partial n} + T_{yy}\frac{\partial y}{\partial n} + T_{zy}\frac{\partial z}{\partial n} = -F_y,$$
$$T_{xz}\frac{\partial x}{\partial n} + T_{yz}\frac{\partial y}{\partial n} + T_{zz}\frac{\partial z}{\partial n} = -F_z.$$

Also ξ, η, ζ are related to T_{xx}, &c., by the formulæ—

$$2(1+m)\,T_{xx} = E\left(\frac{2m}{1-2m}\,\theta + 2\frac{\partial \xi}{\partial x}\right), \text{ \&c.,}$$

E being the modulus of elasticity, m the coefficient of contraction and $\theta = \frac{\partial \xi}{\partial x} + \frac{\partial \eta}{\partial y} + \frac{\partial \zeta}{\partial z}$, whence are deduced $\Delta^2 \xi + \frac{1}{1-2m}\frac{\partial \theta}{\partial x} = 0$, with three corresponding equations. The body S is then supposed to be a sphere of radius R, whose centre is the origin. It is assumed that on its surface $F_y = F_z = 0$,

and F_x is an arbitrary function. Also F_x is at first assumed to satisfy the conditions required by the existence of a function ϕ_1, a solution of Dirichlet's problem relative to the sphere S, and coinciding on the surface of S with RF_x.
S. H. B.

1144. *Kinematical Elastic Formulæ.* **P. Duhem.** (Comptes Rendus, 136. pp. 139–141, Jan. 19, 1903.)—The coordinates of a material point in any medium in its actual state are $x = a + \xi$, $y = b + \eta$, $z = c + \zeta$, where a, b, c are the coordinates in the initial state. The deformation which the body undergoes in passing from the initial to the actual state can be expressed in terms of the six quantities ϵ_1, ϵ_2, ϵ_3, γ_1, γ_2, γ_3, the partial derivatives of ξ, η, ζ with regard to a, b, c. Reference is made to E. et F. Cosserat (Sur la Theorie de l'Elasticité Annales de Fac. Sc. Toulouse, 1. Serie X., 1896). The writer points out that the solution of the problem depends on an equation of the third degree in ϵ_i, γ_i. He then supposes the actual state to undergo infinitely small variation, ϵ becoming $\epsilon + \delta\epsilon$, &c. Then the new infinitely small deformation can be expressed in terms of three dilatations and three shears, referred either to fixed axes 0_x, 0_y, 0_z, or to systems of axes different at different points, coinciding with the principal axes of dilatation at each point in the completed system.
S. H. B.

1145. *Viscosity of a Vitreous Medium.* **P. Duhem.** (Comptes Rendus, 136. pp. 281–283, Feb. 2, 1903.)—This is a continuation of the writer's note [see preceding Abstract] "on certain kinematical formulæ useful in the general theory of elasticity," and the same notation is employed. A vitreous medium is defined to be one, every state of which can be considered as produced by a finite deformation from a homogeneous isotropic initial state. Such a medium is capable of all states intermediate between perfect fluid and homogeneous elastic solid of high rigidity. Tammann, according to the author, has proved that the transition between these states is continuous. The state of any element is completely determined if we know the principal axes of dilatation at the point, and the ratios σ_1, σ_2, σ_3 of the former note, namely, the ratios between the undisplaced and the displaced coordinates referred to these axes of a point infinitely near the point in question. An expression is given for the dissipation function—a quadratic function, namely, of Δ_1', Δ_2', Δ_3', Γ_1', Γ_2, Γ_3 of the former note with coefficient functions of the σ's. Then he writes—

$$a(\sigma, \sigma', \sigma'') = a(\sigma, \sigma'', \sigma') \quad b(\sigma, \sigma', \sigma'') = b(\sigma, \sigma'', \sigma') \quad c(\sigma, \sigma', \sigma'') = c(\sigma, \sigma'', \sigma')$$
$$f(\sigma, \sigma', \sigma'') = f(\sigma, \sigma'', \sigma')$$

where the coefficients a, b, &c., are functions of the absolute temperature. An expression is given for the work done $d\mathrm{T}$, in any small virtual variation, in terms of the Δs', Γs' and the dissipation. The formulæ hence deduced enable us to apply to vitreous media many of the propositions established for viscous fluids. [See also Abstracts Nos. 867 and 870 (1903)]. S. H. B.

1146. *Equations of Motion and Supplementary Relations in the Interioi of a Vitreous Medium.* **P. Duhem.** (Comptes Rendus, 136. pp. 343–345, Feb. 9, 1903.)—The author here continues his investigation of the vitreous medium discussed in two former papers [see Abstracts Nos. 867 and 870 (1903) and preceding Abstract]. He gives expressions for the potential energy, and for the quantity of heat disengaged by an element of mass in any actual or virtual modification of the system. The supplementary relation promised, is an expression for the deformation. Incidentally he gives a condition for the medium being vitreous. S. H. B.

1147. *Point Functions and Point Vectors in Fluid Motion.* **P. Appell.** (Comptes Rendus, 136. pp. 186–189, Jan. 26, 1903.)—The term "point function" or "point vector" is taken from Lamé to denote functions and vectors which have at any point a definite value independent of the choice of axes of reference. In the present paper are considered point functions and vectors formed from the component velocities u, v, w, and their derivatives according to x, y, z; also from the accelerations, u', v', w', of a point in the fluid.

Any point function deduced from the velocity is a function of the time t, and its derivation with regard to t consists of two parts, one depending on the velocity and acceleration, for instance, $(\partial V/\partial x)$, the other is a point function of the velocity $(u\partial V/\partial x)$.

The writer gives examples. In the theory of elasticity we have the well-known functions—

$$\epsilon_1 = \frac{\partial u}{\partial x}, \quad \epsilon_2 = \frac{\partial v}{\partial y}, \quad \epsilon_3 = \frac{\partial v}{\partial z}$$

$$\gamma_1 = \frac{\partial w}{\partial y} + \frac{\partial v}{\partial z}, \quad \gamma_2 = \frac{\partial u}{\partial z} + \frac{\partial w}{\partial x}, \quad \gamma_3 = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}$$

$$2\xi = \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}, \quad 2\eta = \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}, \quad 2\zeta = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$$

where ξ, η, ζ are the components of the rotation vector for x, y, z. From these he forms six other fundamental functions—$\theta = \epsilon_1 + \epsilon_2 + \epsilon_3$

$$\partial = \gamma_1^2 + \gamma_2^2 + \gamma_3^2 - 4(\epsilon_1\epsilon_2 + \epsilon_1\epsilon_3 + \epsilon_2\epsilon_3) \quad \kappa = 4\epsilon_1\epsilon_2\epsilon_3 + \gamma_1\gamma_2\gamma_3 - \epsilon_1\gamma_1^2 - \epsilon_2\gamma_2^2 - \epsilon_3\gamma_3^2$$

$$\Omega^2 = \xi^2 + \eta^2 + \zeta^2 \quad \phi = \epsilon_1\xi^2 + \epsilon_2\eta^2 + \epsilon_3\zeta^2 + \gamma_1\eta\zeta + \gamma_2\xi\zeta + \gamma_3\xi\eta$$

and ψ, a fourth degree function, which need not be written down. He also forms corresponding expressions, using the accelerations u', v', w' instead of u, v, w. Thus are obtained the results—

$$\frac{d\Omega^2}{dt} = 2(\xi\xi' + \eta\eta' + \zeta\zeta') - 2\theta\Omega^2 + 2\phi.$$

From the other five quantities are obtained analogous results, for instance—

$$\frac{d\theta}{dt} = \epsilon_1' + \epsilon_2' + \epsilon_3' - \theta^2 - \frac{1}{2}\delta + 2\Omega^2.$$

He promises to develop the subject on these lines in a paper to appear in the *Journal of Mathematics* of Jordan. S. H. B.

1148. *Principle of Least Action.* **O. Heaviside.** (Nature, 67. pp. 297–298, Jan. 29, 1903.)—The author objects to the use of the Principle of Least Action in finding equations of motion. The Principle states strictly, that the Action in the natural course from an initial to a final configuration is less than in any slightly varied course with the same total energy, provided that no kinetic focus is passed through. Thomson and Tait once expressed their opinion that in competent hands it would prove a valuable instrument of research. But they intended, perhaps, not the above special sense but a more general one. Newton's Principle of Activity, he says, furnishes an answer to the problem—given the stress operator P in an elastic body to find $\dot{\mathrm{T}}$ and $\dot{\mathrm{U}}$ and corresponding functions. He starts from the equation div. $q\mathrm{P} = \dot{\mathrm{U}} + \dot{\mathrm{T}}$, whence is deduced $\mathrm{F}q = \dot{\mathrm{T}}$, $\mathrm{G}q = \dot{\mathrm{U}}$, and F and G are discussed. He also shows how Lagrange's equations can be deduced from the Principle of Activity. [But this is not new.] S. H. B.

1149. *Reciprocal Influence of Neighbouring Oscillators.* **M. Brillouin.** (Comptes Rendus, 136. pp. 301–303, Feb. 2, 1903.)—The motions of the two oscillators X and Y (which are not necessarily electric) are in a field of external force, X for the one, Y for the other. The general equations of motion are of the form—

$$\frac{d^2x}{dt^2} + 2h\frac{dx}{dt} + (a^2 + h^2)x = \mathrm{X}, \qquad \frac{d^2y}{dt^2} + 2h\frac{dy}{dt} + (b^2 + h^2)y = \mathrm{Y}.$$

The two bodies are in the same medium, in which disturbances are propagated with velocity Ω. The mutual influence of the oscillators must be included in X and Y. It will be of the retarded type. If r be the distance between the oscillators, and $\frac{r}{\Omega} = \tau$, the force exerted by one on the other has the form—

$$\mathrm{AM}\left(y + \tau\frac{dy}{dt} + m\tau^2\frac{d^2y}{dt^2}\right) \text{ for X}, \qquad \mathrm{BM}\left(x + \tau\frac{dx}{dt} + m\tau^2\frac{dx^2}{dt^2}\right) \text{ for Y},$$

A and B being inversely proportional to the masses. M and m are coefficients depending on the distance and orientations of the oscillators. It is shown that one oscillator receives a series of impulses at intervals of time 2τ, 4τ, &c., generally $2n\tau$ and the other at intervals generally $2n - 1\ \tau$. In like manner, the original impulse which set X in motion is reproduced at intervals 2τ but, as shown, changes its character. It undergoes gradual diminution. The writer concludes with the proposition that a sudden displacement ∂x_0 of X, produces in the second, not only a sudden corresponding displacement, but also a sudden change in the velocity of the form $\mathrm{BM}(1 - 2km\tau)\partial x_0$, where k is constant. [See also Abstract No. 330 (1903).] S. H. B.

1150. *Waves in Elastic Media.* **J. Boussinesq.** (Comptes Rendus, 136. pp. 337–342, Feb. 9, 1903.)—The paper treats of the gradual decay of motion in the rear of an isolated wave in an elastic medium in which there acts a resistance proportional to the velocity, or to the displacement. The general equation applicable to the problem is $\frac{d^2u}{dt^2} + a\frac{du}{dt} = \frac{d^2u}{dx^2} - bu$, where a and b are positive constants. Writing $u = e^{-\frac{at}{2}}\phi$, and $\pm 4k^2 = \frac{a^2}{4} - b$, this becomes $\frac{d^2\phi}{dt^2} = \frac{d^2\phi}{dx^2} \pm \mathrm{L}k^2\phi$ (3), and he gives the solution in the form—

$$\phi = d\frac{d}{dt}\int_{-t}^{t} f(x + \tau)d\tau\int_0^{\frac{\pi}{2}}\mathrm{CO}(2\sqrt{k^2t^2 - k^2\tau^2}\cos\theta)\frac{d\theta}{\pi}$$

$$+ \int_{-t}^{t}\mathrm{F}(x + \tau)d\tau\int_0^{\pi}\mathrm{CO}(2\sqrt{k^2t^2 - k^2\tau^2}\cos\theta\,\frac{d\theta}{\pi}$$

in which CO denotes a hyperbolic, or a circular, cosine according as the upper or lower sign is used with $\mathrm{L}k^2\phi$ in (3). Also $f(x)$ and $\mathrm{F}(x)$ are arbitrary functions denoting the initial values of ϕ and $\frac{d\phi}{dt}$. In treating the problem, x denotes the abscissa of a point in the medium, X is the abscissa $x + \tau$ of an element $dX = d\tau$ in the disturbed region. In the first place the resistance is assumed proportional to the velocity. Further it is assumed that $f(x) = 0$, *i.e.*, no initial displacements, but that there are initial velocities $F(X)$. He finds that the decay of the motion depends in this case on the factor—

$$e^{-2(kt - \sqrt{k^2t^2 - k^2\tau^2})} \Big/ L\sqrt{\pi\sqrt{k^2t^2 - k^2\tau^2}}$$

that is if $k\tau$ is comparable to $\sqrt{kt}$, the rate is inversely proportional to $e^{\frac{k\tau^2}{t}}\sqrt{kt}$, and if $k\tau$ is small compared with $\sqrt{kt}$, it is nearly proportional to $\frac{1}{\sqrt{k\tau}}$. This he says is, strictly speaking, due to friction destroying the initial total momentum which we have supposed given to the wave, and the result would be inapplicable to a wave in which there is no initial momentum. For this latter case, the rate of decay is found to depend on the term $\frac{\sqrt{k}}{4t\sqrt{\pi t}}$, and is less as $\sqrt{k}$ is greater, that is the less the greater the friction. Next he considers the case in which there is initial displacement, but no initial velocities, and, finally, that in which the resistance is proportional, not to the velocity, but to the displacement. In this case he obtains—

$$u = -\sqrt{\frac{k}{\pi t}}\int f(X)\sin\left(2kt - \frac{\pi}{L} - k\frac{\tau^2}{t}\right)dX,$$

$$+\frac{1}{2\sqrt{\pi kt}}\int f(X)\cos\left(2kt - \frac{\pi}{L} - k\frac{\tau^2}{t}\right)dX.$$

For small values of $k\tau^2$—

$$\sin\left(2kt - \frac{\pi}{4} - k\frac{\tau^2}{t}\right) = \sin\left(2kt - \frac{\pi}{4}\right) - k\frac{\tau^2}{t}\cos\left(2kt - \frac{\pi}{4}\right)$$

and—

$$\cos\left(2kt - \frac{\pi}{4} - k\frac{\tau^2}{t}\right) = \cos\left(2kt - \frac{\pi}{4}\right) + k\frac{\tau^2}{t}\sin\left(2kt - \frac{\pi}{4}\right)$$

The two terms involving τ^2 are of the order $\frac{1}{t\sqrt{t}}$, but the values of u derived from them, instead of decreasing continuously to zero as u increases, oscillates about zero with a period inversely proportional to the square root of the coefficient of resistance. S. H. B.

1151. *Sliding Motions in Fluids.* **Hadamard.** (Comptes Rendus, 136. pp. 299–301, Feb. 2, 1903.)—In explaining the resistance offered by a fluid to a solid moving through it, it is usual to assume that surfaces of discontinuity are formed separating the fluid into two parts, of which one slides, so to speak, over the other. Hadamard seeks to prove in this note that this usual assumption, like many other usually accepted assumptions, is in fact impossible, at least if certain conditions are fulfilled. The conditions are: (1) That the surface of discontinuity S is determinate, and that no mixture takes place between the molecules of the separated portions—that is, that we may neglect the phenomena of local rotation considered by Boussinesq. This hypothesis is, he says, certainly inexact, but is considered sufficient in hydrodynamics, and is always assumed in the explanation of the resistance above mentioned; (2) That no cavities are formed between the two neighbouring parts of the fluid; (3) That the velocity never varies discontinuously. The proof rests on the fact that at any instant the pressure is a continuous function of the coordinates—from which it follows by a theorem of Hugoniot, that the discontinuous change in acceleration in passing through S is normal to S. This is expressed by two differential equations as follows: Consider all those molecules in the first region which are successively in contact with a given molecule of the second region. Let ξ, η be the curvilinear coordinates on S defining the position of a molecule. Then for each of these molecules of the first region ξ, η are functions of the time. The condition that the discontinuous increase of acceleration should be normal to S is of the form—

$$\frac{d^2\xi}{dt^2} = \mathrm{A}\left(\frac{d\xi}{dt}\right)^2 + 2\mathrm{B}\frac{d\xi}{dt}\frac{d\eta}{dt} + \mathrm{C}\left(\frac{d\eta}{dt}\right)^2 + 2\mathrm{D}\frac{d\xi}{dt} + 2\mathrm{E}\frac{d\eta}{dt}$$

with corresponding form for $\frac{d^2\eta}{dt^2}$. A, B, C, &c., depend on the geometrical conditions of the element of S. These equations show that $\frac{d\xi}{dt}$, $\frac{d\eta}{dt}$, once zero, are always zero. Therefore he infers there can be no sliding, or else that one of the conditions (1), (2), (3), must be rejected. The paper concludes with a proposition relating to waves in gases, namely, that such waves are capable of creating rotating motion where none existed before, which is contrary to the law of conservation. S. H. B.

1152. *Waves in Elastic Media.* **J. Boussinesq.** (Comptes Rendus, 136. pp. 427–430, Feb. 16, 1903.)—Following Hugoniot (Comptes Rendus, 101. p. 794), the author gives a direct and simple calculation of the velocity of propagation of the front or head of a wave in a medium for which the equations of motion are complicated, and seeks here to apply the simple demonstration to the case of any change "*u*" of the physical state of a medium of which one portion, bounded by a certain surface, retains its primitive condition, and the change of *u* comes over from the other side of the surface.

A line normal to the surface (supposed plane) is taken for axis of x, and the medium is supposed homogeneous. Then as the change u arises in a part previously undisturbed, u is less than $\frac{du}{dx}$, or $\frac{du}{dt}$, because—

$$u = \int_0^t \frac{du}{dx}dx < \frac{du}{dx}x = \int_0^t dx.$$

Similarly $\frac{du}{dx}$ or $\frac{du}{dt}$ are less than the second derived coefficients, and so on. The derived coefficient of the highest order (the nth) may be regarded as discontinuous, and we may take cognisance of it, at all events near the head of the wave, so obtaining the equation—

$$a\frac{d^nu}{dx^n} - b\frac{d^nu}{dx^{n-1}dt} + c\frac{d^nu}{dx^{n-2}dt^2} - \ldots = 0 \ldots\ldots\ldots\ldots\ldots (1)$$

The solution of which is $u = f(x - \omega t)$, ω being a root of—

$$a - b\omega + c\omega^2 - \ldots = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Evidently ω is the velocity of propagation. It depends only on the derived coefficients of the nth, or highest, order. If there be only one positive root of (2), the general integral is the sum of n particular integrals, of which all except the single positive one travel towards negative x, and therefore have their origin at $x = +\infty$, and are, therefore, non-existent, because that region is supposed undisturbed. The single positive root expresses the motion. It is shown that the method ceases to be applicable when any derived coefficient of order lower than n is found in the expression for u, while the nth derivatives, of which it might be the integral, are wanting altogether. The case is then considered in which $\frac{d^n u}{dx^n}$, or $\frac{d^n u}{dt^n}$ is wanting. Introducing ϵ as coefficient of the term in question in (1), and then reducing ϵ to zero, we have in the one case $\omega = 0$, or there is no propagated wave; in the second $\omega = \infty$, and the wave passes instantaneously to the undisturbed region at infinite x. Finally the case is considered, in which the initial state, $u = f(x)$ is zero for high positive values of x. [See also Abstract No. 300 (1903).] S. H. B.

1153. *Resistance of Perfect Gases to the Motion of Solids.* **L. Jacob.** (Comptes Rendus, 136. pp. 492–495, Feb. 23, 1903.)—A projectile moving through the air with velocity greater than that of sound has, as is well known, in front of it a wave of compression, and behind it one of dilatation. If we suppose the system to have impressed upon it a velocity equal to that of sound in a direction contrary to the motion, we have stationary waves in the fluid. In front of the wave there is no disturbance. At one point of the wave, the normal velocity of propagation, *i.e.*, the velocity of sound, is equal to the velocity of the fluid normal to the wave surface. This, says the writer, explains the paradox that two surfaces in contact in the gas have finite difference of pressure. On these data it is shown that if y be the ordinate of a meridian section of the wave, y' can be determined as a function of ϕ, the angle between the normal to the wave surface and the direction of motion. Also the equation of continuity in cylindrical coordinates is $\rho y(udy - vdx) = d\mathrm{F}$, u and v being component velocities, and he shows how F can be found. The result obtained is of use in the integration of the equations of motion. The problem is reduced to the integration of a differential equation of the second order in $\sin\phi$, a function of x and y. S. H. B.

1154. *Natanson's Theory of Viscosity.* **St. Zaremba.** (Acad. Sci. Cracovie, Bull. 2. pp. 85–93, Feb., 1903.)—The author undertakes to show that certain equations given by Natanson ("On the Laws of Viscosity Bulletin international de l'Acad. Cracovie, 1901, equations 9a, 9b, 9c, 10a, 10b, 10c" [see Abstract No. 14 (1902)]) are inexact, on the ground that, while they relate to the relative velocities of the particles of the liquid, they would be affected by any uniform rectilinear motion of the vessel containing the liquid. It is sufficient to consider one equation, namely—

$$p_{x'x'} - p = \mathrm{C}_{x'x'}\, e^{-\frac{t}{\mathrm{T}}} - e^{-\frac{t}{\mathrm{T}}} \int dt\, e^{\mathrm{T}}\, \Omega \text{ ....(2)}$$

in which $p_{x'x'}$ is the normal component of, in the writer's notation, pressure per unit of surface for x'. $\Omega = 2n\frac{\partial u}{dx'} + \left(k - h - \frac{2}{3}n\right)\left(\frac{\partial u}{dx'} + \frac{\partial v}{dy'} + \frac{\partial w}{dx'}\right)$ T, n, k, h are constants depending on the nature of the liquid, u, v, w the component velocities of a particle, and p a quantity depending only on the state of the liquid at the point considered, and $\mathrm{C}_{x'x'}$ is a constant independent of the time. Here x', y', z' are coordinates of a particle referred to axes fixed in the liquid. The author now supposes a set of axes $0x$, $0y$, $0z$ fixed in space, and the system of axes of x', y', z always parallel to them, but the liquid with the axes of x', y', z' fixed in it, moving in space with uniform velocities λ, μ, ν, and at the epoch $t=0$ the two systems coincided, so that $x = \lambda t + x'$, $y = \mu t + y$, $z = \nu t + z$ or $x' = x - \lambda t$, &c. Then writing ϕ for $p_{x'x'} - p_x$ in equation (2), ϕ is a function of x', y', z' and t, which, since $x' = x - \lambda t$, &c., we may write $\phi = f(\overline{x - \lambda t}, \overline{y - \mu t}, \overline{z - \nu t}, t)$ whence it follows that $t\frac{d\phi}{dx} + \frac{d\phi}{d\lambda} = 0$, $t\frac{d\phi}{dy} + \frac{d\phi}{d\mu} = 0$, $t\frac{d\phi}{dz} + \frac{d\phi}{d\nu} = 0$. The author proceeds to apply the formula $t\frac{d\phi}{dx} + \frac{d\phi}{d\lambda} = 0$ to the equation (2) $\phi = \mathrm{C}e^{-\frac{t}{\mathrm{T}}} - e^{-\frac{t}{\mathrm{T}}}\int e^{\mathrm{T}}\Omega\, dt$ to see if they are consistent. We have—

$$0 = t\frac{d\phi}{dx} + \frac{d\phi}{d\lambda} = e^{-\frac{t}{\mathrm{T}}}\left(t\frac{dc}{dx} + \frac{dc}{d\lambda}\right) - te^{-\frac{t}{\mathrm{T}}}\int e^{\frac{t}{\mathrm{T}}}\frac{d\Omega}{dx}\, dt - e^{-\frac{t}{\mathrm{T}}}\int e^{\frac{t}{\mathrm{T}}}\frac{d\Omega}{d\lambda}\, dt.$$

Now concerning C or $\mathrm{C}_{x'x'}$, Natanson assumes nothing except that it is independent of the time. Therefore $t\frac{dc}{dx} + \frac{dc}{d\lambda} = 0$. The second term our author writes $-te^{-\frac{t}{\mathrm{T}}}\int e^{\frac{t}{\mathrm{T}}}\frac{d\Omega}{dx}\, dt$, putting the factor t outside of the integral. But since the time in Natanson's integral $\int e^{\frac{t}{\mathrm{T}}}\frac{d\Omega}{dx}\, dt$ is not measured from the same epoch as the factor t in $t\frac{d\phi}{dx} + \frac{d\phi}{d\lambda}$, this last factor ought, perhaps, to be put under the integral sign, in which case the two last terms give—

$$-e^{-\frac{t}{\mathrm{T}}}\int e^{\frac{t}{\mathrm{T}}}\left(t\frac{d\Omega}{dx} + \frac{d\Omega}{d\lambda}\right) dt,$$

and are zero, because $t\frac{d\Omega}{dx} + \frac{d\Omega}{d\lambda} = 0$. However, our author keeps t outside of the integral, the consequence being that the two last terms are equal to $\int dt \int dt\, e^{\frac{t}{\mathrm{T}}}\frac{d\Omega}{dx}$. In order, therefore, that (2) may be consistent with $t\frac{d\phi}{dx} + \frac{d\phi}{d\lambda} = 0$, we must, on the author's showing, have $\int dt \int dt\, e^{\frac{t}{\mathrm{T}}}\frac{d\Omega}{dx} = 0$, and therefore $\frac{d\Omega}{dx} = 0$. Therefore Natanson's equation (2) cannot be true except in the special case when $\frac{\Omega}{dx} = 0$. The writer further says that Natanson bases his theory on certain assumptions, among others that the motion of the liquid is very small, so that (2) may be only approximate, and he goes on to consider whether or not it can hold as an approximation. He answers in the negative. So he proves to his own satisfaction that Natanson's equations are altogether inexact; and he gives a syllabus of the works involved in this condemnation. [See Natanson's paper Acad. Sci. Cracovie, Bull., 1908.]

S. H. B.

1155. *Fortnightly Tide.* **Rayleigh.** (Phil. Mag. 5. pp. 136–141, Jan., 1903.)—The fortnightly tide would afford data for the earth's rigidity. If the fortnightly tide be sensibly equal to its equilibrium value, the earth must be (G. Darwin) at least as rigid as steel. The question whether an equilibrium theory is adequate is considered and discussed. It would not be, if there could be free steady motions; but these are, on the whole, prevented by the great land barriers, and the fortnightly tide cannot differ materially from its equilibrium value; therefore G. Darwin's calculation stands. New data and calculations are, however, required for the case of an ocean of uniform depth, bounded by two meridians. A. D.

1156. *Hydrographical Work of the North Sea Investigation Committee* (*Scotland*). **D'A. W. Thompson.** (Nature, 67. pp. 246–247, Jan. 15, 1903.)—After a hydrographical cruise in the North Sea in August and September, 1902, H.M.S. *Jackal*, Commander Sharp, started on Dec. 4 on a fresh cruise, on approximately the same course as laid down by H. N. Dickson, between Orkney, Shetland, Faeroe, and Norway, returning on Dec. 15, 1902. Sharp collected 125 water samples at twenty stations, and took temperatures. The author gives a preliminary account of these latter, showing that the cold current wedge had shifted westward. While at one station the temperatures decreased from 9·5° at the surface, to 7·9° at a depth of 460 m., at an adjoining station the following temperatures were observed: 2·12° at 500 m., + 0·34° at 600 m., — 0·25° at 700 m., and — 0·8° at 1,100 m. H. B.

1157. *Variation of Wind Velocity in the Vertical.* **A. Egnell.** (Comptes Rendus, 136. pp. 358–361, Feb. 9, 1903.)—The wind velocity increases rapidly as we pass through the surface layers up to a height of about 300 m., where the surface-friction becomes negligible. Multiplying the wind velocity, as deduced from cloud observations at Trappes, by $b/760$, and without making any allowance for the temperature diminution in the upper strata, the author arrives at the conclusion that the quantity of air displaced is constant for all elevations between 300 m. and 12 km., or that the wind velocity varies inversely as the density of the air. This law seems to agree with the observations made at Upsala, Bossekop, Blue Hill and Washington (all within the temperate zone), but not for Manila (in the tropics), where the wind velocity decreases with increasing altitude. H. B.

1158. *Absorption of Atmospheric Ammonia by Water.* **J. Thoulet.** (Comptes Rendus, 136. pp. 477–478, Feb. 16, 1903.)—Sea water from great depths being filtered several times was found to increase in free and albumenoid ammonia. A similar, but less marked, increase was observed in distilled water, and also when sea or distilled water was passed, drop by drop, from one vessel into another. Ammonia seems therefore to be absorbed directly from the atmosphere. H. B.

1159. *High Winds on the Pacific Coast.* **A. G. McAdie** and **W. W. Thomas.** (Monthly Weather Rev. 31. pp. 64–68, Feb., 1903.)—At the weather bureau station of Point Reyes Light, completed early in 1902, strong gales were experienced on Feb. 23 to 25, March 1, and May 18 to 20. The Robinson cup anemometer several times recorded velocities of more than 100 miles per hour; on May 18, the average velocity was 78 miles and the extreme 120 miles. The anemometer was detached from the spindle which remained intact, and lost; the anemometer is itself 593 ft. above sea-level. H. B.

1160. *Rings around the Sun, and Twilight Glows.* **H. H. Clayton.** (Science, 17. pp. 150–152, Jan. 23, 1903.)—Rings around the sun, so-called "Bishop's rings," were noticed at the Blue Hill Observatory for a fortnight after Dec. 28, 1902. The whitish glare extended to about 20° from the sun; the purple-red glare, which appeared later—towards sunset—had its minimum intensity about 40° from the sun. The glare was caused by whitish striæ extending north to south and resembling cirrus haze. Twilight glows were observed, particularly in November and December; the orange tint, seen immediately after sunset, passed into a first purple arch and a second purple glow. H. B.

1161. *Oblique Band on Jupiter.* **Amann.** (Comptes Rendus, 136. pp. 292–293, Feb. 2, 1903.)—While the bands observed on the surface of the planet Jupiter are always quite parallel to the equator, yet oblique bands have been observed by Chambers. The author has observed, in the southern hemisphere of the planet, such an oblique band four times between July 4, 1902, and Jan. 22, 1903. The most striking observation was made on Dec. 13, 1902, when the band was seen at an inclination of 12° between 20° and 40° southern latitude. One end of the band was about 20° from the eastern side of the planet, and the other 23° from the western side. The author considers that these observations should furnish valuable information as to the duration of formation of all the bands generally; the usual type of parallel bands can give no data as they, as a rule, completely encircle the planet. Further, he considers that the oblique bands are due to the formation of an immense solid mass which moved eccentrically to the axis of rotation in a more or less plastic surface medium. E. C. C. B.

1162. *Physical Constitution of Jupiter.* **G. W. Hough.** (Science, 17. pp. 81–93, Jan. 16, 1903. Paper read before the A.A.A.S. (Section A.), at Washington, Dec. 29, 1902.)—After a discussion of the work of various observers, the author puts forward the following theory as the one which, in his opinion, gives the most satisfactory explanation. The visible boundary of Jupiter is assumed to have a density of about half that of water. This medium is in the nature of a liquid; in it are located the great red spot and the egg-shaped white spots. In such a medium, all motions in longitude and latitude would be slow and gradual, and the shape and size of the object would have great permanency. The equatorial belt and the so-called polar belts may be located on the surface or at a higher level than the red spot. In the middle latitude, within 20° of the equator, the higher atmosphere carries a layer of dark matter, in the direction of the rotation of the planet, at a velocity of about 250 miles per hour, making a complete circuit around the planet in 44 days. In this envelope are formed the openings known as white spots, and by unequal distribution, black spots. The great bay in the south edge of the equatorial belt may be accounted for by assuming that the great red spot is at a lower temperature than the medium in which it floats, and, owing to this, condenses a portion of the vapour composing the belt. The belts may be assumed to consist of some sort of vapour of considerable density. The cloud-like matter, which in the equatorial regions is moving over the surface at the rate of 250 miles per hour, would account for the minor changes on the surface of the equatorial belt. G. W. DE T.

1163. *The Universe as an Organisation.* **S. Newcomb.** (Science, 17. pp. 121–129, Jan. 23, 1903. Paper read before the Astronomical and Astrophysical Society of America, Dec. 29, 1902.)—After some remarks on stellar motions and distribution, and on the close connection shown to exist between solar disturbances and terrestrial magnetism, the author discusses the formation of the new Nebula around Nova Persei. Its growth is too rapid to be explained by projection of matter, or even, as suggested by Kapteyn, by the illumination of previously existing nebulous matter by a light wave from the exploded star. If the distance of the star were even so small as 400 times that of α "Centauri," the speed of the apparent expansion must be ten times the velocity of light. The conclusion seems inevitable that either the illumination or nebulosity surrounding Nova Persei during the summer of 1902 existed independently of the outburst of the star, or something exists in the universe, susceptible of transmission with a speed several times that of light. The light theory referred to was further negatived by the fact that, according to the Lick photograph, the emanation branched in an irregular manner and with varying speed. In conclusion, the author points out how physical research, which formerly showed increasing differentiation, is now tending more and more towards unification. G. W. DE T.

1164. *Radial Velocities of Stars. Causes of Error Peculiar to these Investigations.* **H. Deslandres.** (Comptes Rendus, 136. pp. 204–211, Jan. 26, 1903.)—In this note are given the measurements of the variable velocities of certain stars made during the year 1902. In the case of θ Aquilæ the displacement measurements were made upon the line at $\lambda = 4481$ (magnesium) on twenty-six plates, and they give a period of 17 days. It is just possible that there is a shorter period of three days superposed upon the first; this, however, is very doubtful. This star is the first white star of type VII. (Pickering) which has been shown to be a spectroscopic double. A second star observed was ϕ Persei, and the measurements confirm Campbell's discovery that the star has a variable velocity. The hydrogen lines in this star are bright with a central reversal, and as the measurements were made on these centres, the velocities obtained refer to the atmosphere of the star. The third star examined was ψ Persei, a white star with bright hydrogen and black metallic lines; the general nature of the spectrum is very similar to the Nova Persei recently appeared. The second part of the paper refers to the sources of error liable to occur in these measurements without, however, any new points being raised. E. C. C. B.

1165. *Free Phosphorus in a Meteorite.* **O. C. Farrington.** (Amer. Journ. Sci. 15. pp. 71–72, Jan., 1903.)—On drilling a hole into the Saline Township meteorite, white smoke, smelling of phosphorus, was noticed. The interior showed a luminous spot, silver nitrate was blackened, and the powder from the drilled hole gave a precipitate of ammonium-phospho-molybdate. The author therefore believes that free phosphorus was present; two other holes did not reveal any phosphorus. H. B.

REFERENCES.

1166. *Snow-Crystals.* **W. A. Bentley.** (Monthly Weather Rev. 30. pp. 607–616, 1902.)—Over 250 photomicrographs of snow-crystals, taken during the winter of 1901–2, are given, together with meteorological data of the storms in which they were collected. T. M. L.

1167. *Motion of a Rigid Body.* **C. Burali-Forti.** (Accad. Sci. Torino, Atti, 38. Nos. 4a. and 5a. pp. 91–106, 1902–3.)—This is a paper of purely mathematical interest. The writer seeks to simplify the geometry of a rigid body in motion by using the notation of quaternions, as in his memoir on plane-toothed wheels. [See Abstract No. 5 (1903)]. S. H. B.

LIGHT.

1168. *Optical Properties of Thin Metal Plates.* **G. T. Walker.** (Ann. d. Physik, 10. 1. pp. 189–197, Dec. 30, 1902.)—The complicated expressions obtained by applying Cauchy's theory to the case of a thin metallic plate are simplified by approximation. Calculations are then made for the cases in which sodium light passes through thin gold and silver plates of thickness varying between zero and 10^{-5} cm.; the curves drawn, showing the variation of transparency and reflecting power with thickness, are verified by means of Hagen and Rubens' results. The latter, consequently, give additional support to the electro-magnetic theory of light. G. E. A.

1169. *Size of Ultra-microscopic Particles.* **H. Siedentopf** and **R. Zsigmondy.** (Ann. d. Physik, 10. 1. pp. 1–39, Dec. 30, 1902.)—A method is described by means of which ultra-microscopic gold particles are made visible and counted. It consists in illuminating a piece of the prepared material laterally, by means of a bright source, slit and condenser. The gold particles in the track of the beam then become intensely luminous, and produce diffraction effects perceptible in a microscope, although the particles themselves may be much smaller than half a wave-length of light. Taking the particles of gold in ruby glass to be cubical in shape, their size is calculated, and is found to vary, in different specimens of glass, between 3·9 and 791$\mu\mu$. There are, however, reasons for concluding that the gold is present in the shape of lamellæ. No relation was found to hold between the colour of the particles and their size; in some ruby glasses, and also in colloidal gold solutions, there are red-colouring gold particles smaller than the smallest ones measured, *i.e.*, less than 4 to 7$\mu\mu$. [See also Abstract No. 600 (1903).] G. E. A.

1170. *Standardising Astronomical Eyepieces.* **J. J. Hall.** (British Optical Journ. 2. pp. 140–141, Feb., and pp. 163–165, March, 1903. Paper read before the Optical Society, Jan. 15, 1903.)—Berthon's method consists in placing the eyepiece about 10 in. above a black disc 1 in. in diameter, and measuring the image of the disc by means of a "dynameter," a V-shaped opening graduated along one limb of the V in 500ths of an inch. The ratio—diameter of object/diameter of image—gives the standard number for the eyepiece, and this number multiplied by one-tenth of the focal length of the objective in inches, gives the power of the telescope. For high-power eyepieces, discs of 2 and 3 in. diameter are employed. G. E. A.

1171. *Optical Inactivity of Aqueous Solutions of Antitartaric Acid.* **L. Marchlewski.** (Acad. Sci. Cracovie, Bull. 1. pp. 7–8, Jan., 1903.)—The author points out that though we may explain the optical inactivity of non-dissociated antitartaric acid by assuming intramolecular compensation, such an explanation cannot be extended to aqueous solutions of antitartaric acid. In the latter case there is dissociation, together with optical inactivity, so that the optical inactivity must be due to extra-molecular compensation amongst the ions. D. H. J.

1172. *Clearness of Telescopic Vision.* **S. P. Langley.** (Amer. Journ. Sci. 15. pp. 89–91, Feb., 1903. Paper presented to the National Academy of Sciences, Nov. 12, 1902.)—The author deals with the "boiling" of the images of stars, &c., as seen in telescopes, arising from convection currents in the atmosphere. The main effect is due to these currents in the near neighbourhood of the instrument, and the author has carried out some experiments with a view of minimising their effect. He found that carefully keeping the air tranquil, by shielding from temperature changes, had but little effect; on the other hand, vigorous stirring by a fan produced a very marked improvement in the definition, which is shown by an illustration. E. C. C. B.

1173. *Screens Transparent only to Ultra-Violet Light, and their Use in Spectrum Photography.* **R. W. Wood.** (Phil. Mag. 5. pp. 257–263, Feb., 1903.) —The substance nitroso-dimethylaniline has an absorption band between the limits $\lambda = 5{,}000$ and $\lambda = 3{,}900$, but beyond the last limit it is quite transparent to as far as $\lambda = 2{,}000$. By combining a layer of this substance with layers which absorb the red, yellow, and green rays, a screen can be made transparent only to ultra-violet light. Very dense cobalt glass, coated with a thin film of gelatine lightly stained with the nitroso body, coupled with a thin sheet of Chance's signal-green glass, answers admirably, as it absorbs all the rays except those between the limits $\lambda = 3{,}400$ and $\lambda = 3{,}800$. Considerable care must be used in the adjustment of the strength of the solution of the nitroso body in gelatine. The best strength is such that it will just remove the blue and violet light transmitted by the cobalt glass. When the balance is right between the three components of this screen, it is possible to form a focus in which a piece of white paper is quite invisible, but a mass of uranium nitrate crystals glows with great intensity. For spectrum photographic work there is no need to cut out the rays in the green or orange, because the chief use of the substance is to separate the higher orders of superimposed spectra and allow only the ultra-violet lines to be photographed. For this purpose, a gelatine film, stained with the nitroso body, is fairly suitable, but a better way is to make a solution in glycerine and use it in a quartz cell; as the glycerine is acted on by ultra-violet light, the author employed a small quartz cell, made by cementing two quartz plates together, with a space between of 0·5 mm. This cell was cemented to the bottom of a thistle funnel with a very small bore. By filling the thistle funnel with the glycerine solution, a flow took place through the cell at the rate of about a drop every two minutes. The exposure must be much increased when using the screen, and varies from 2 to 20 times the ordinary, according to the density of the screen.

A very useful screen can be made by combining the nitroso-dimethylaniline with uranine, which last absorbs the bluish-green region of the spectrum. By a proper adjustment of these two in gelatine, a screen can be made which, when used with an ordinary (not isochromatic) plate, gives a photograph entirely taken by light of wave-length $\lambda = 3{,}450 - \lambda = 3{,}650$. The author has taken photographs of the moon through this screen, which show the contrast between bright and dark areas very strongly marked, while in photographs of landscapes taken in the same way, there is almost no contrast at all, except between white objects and objects not white. The author considers it probable therefore that the more luminous portions of the moon's surface, if not as white as plaster-of-Paris, must at least be much whiter than grey sandstone. Two photographs accompany the paper, one taken by yellow light (through an aurantia screen) and the other by ultraviolet light. The absence of contrast between darker objects is very noticeable in the latter; further, there is a complete absence of shadow, even though it was taken in full sunlight, showing that most of the ultra-violet light comes from the sky. The two photographs also show that our eyes have developed a maximum sensibility for that region of the spectrum which shows terrestrial objects in strongest contrast. E. C. C. B.

1174. *Optical Properties of Iodine.* **W. W. Coblentz.** (Phys. Rev. 16. pp. 35–50, Jan., and pp. 72–93, Feb., 1903.)—The absorption of iodine in a solution of carbon bisulphide and ethyl alcohol was measured to $\lambda = 2{\cdot}7\mu$. For the visible spectrum, a horizontal slit spectrophotometer was used, while the infra-red was explored by means of a radiometer. In the visible spectrum the CS_2 solutions have a strong absorption band, maximum at about $0{\cdot}515\mu$, while that of the alcohol solution lies in the ultra-violet. The latter solution becomes dichroic for weak concentrations. All the CS_2 solutions become transparent beyond $1{\cdot}1\mu$, while the alcohol solutions vary in absorption with the concentration, and, like the solvent, become opaque at $1{\cdot}4\mu$. Two absorption bands exist, one in the visible spectrum, the other at $7{\cdot}4\mu$. Liquid iodine was explored to $2{\cdot}7\mu$. Its absorption does not depend upon the temperature, but is less than that of solid iodine. For the long waves the relation of transmission to thickness of solid iodine fulfils the law for optically perfect media with a degree of approximation equal to that of the knowledge of the thickness of the films used. The two polarised rays are unequally absorbed. One is more transparent to the visible rays, while the other is more transparent in the infra-red. Both the solid and liquid iodine show anomalous dispersion. J. W. P.

1175. *Selective Absorption of Fuchsine and Cyanine.* **W. W. Coblentz.** (Phys. Rev. 16. pp. 119–122, Feb., 1903.)—The author has observed the absorption of the two dyestuffs for rays lying between $0{\cdot}7\mu$ and 16μ, and finds that the curves of energy transmitted are very similar in the two cases. Above $\lambda = 9\mu$, the fuchsine transmits very much less than the cyanine; there are for both substances absorption bands at $\lambda = 3{\cdot}5\mu$, $6{\cdot}5\mu$, and $8{\cdot}2\mu$, the last two being more marked. The transmission curves and tables expressing the results are published in the paper. E. C. C. B.

1176. *Radiations from Oxides.* **C. Féry.** (Soc. Franc. Phys., Séances, 1. pp. 8–19, 1903.)—The total heat radiation of oxides for incandescent mantles is considered as affected by temperature. The substances are heated by a Berzelius burner, and the temperatures measured by a Le Chatelier couple. For measuring the radiation an improved thermo-junction arrangement is used. Its essential parts are, a blackened plate of silver to receive the radiation, an iron-constantan couple, and a concentration lens. The luminous radiation from such mantles is also measured for one particular wave-length in the middle of the visible spectrum. This is done by superposing a real image of the mantle upon the filament of an electric incandescent lamp whose energy consumption can be accurately measured. Between 900° and 1,500°, it is found that the laws of Stefan and Wien are satisfied. Various oxides are dealt with, and the influence of the nature and magnitude of the flame are considered. An attempt at a theory of mantles is given. J. W. P.

1177. *Control of the Development Factor.* **V. C. Driffield.** (Photographic Journ. 1. pp. 17–21, Jan., 1903.)—In the ordinary procedure of speed determination, both Hunter and Driffield have hitherto only regarded it as necessary to make a series of exposures in geometrical progression upon a single strip of plate. In order, however, to obtain data to enable the development factor to be controlled, it is necessary to expose two or more strips of the same plate. It is not material what the lengths of time chosen may be. The author, however, develops one strip for exactly twice as long as the other. Having determined the development factors of the two strips, a curve is plotted, showing the factor as ordinates and the times of development in minutes, as abscissæ, from which may be determined the time of development necessary to reach any factor desired, and to obtain the same result as often as required. The author points out that the use of two strips from the same plate is useful in determining the presence of free bromide in the plate, which has a seriously disturbing effect upon speed determination. He explains why (where it is present) the inertiæ of simultaneously exposed strips of the same plate, developed for different lengths of time, decreases with the time of development. Finally, the author advocates the preparation of plates free from any trace of free bromide. C. E. A.

1178. *Some Physical Aspects of Photography.* **T. T. Baker.** (Photographic Journ. 48. pp. 27–32, Feb., 1908.)—The author indicates some of the ways in which ordinary photographic reactions are influenced by physical conditions. He considers the influence of the specific heat of various gelatines in the making of emulsions and shows that the determination of this; of the heats of neutralisation and double decomposition when the gelatine and the salts are mixed: of the capacity for heat of the vessel in which the emulsion is made up; of the specific heat of the emulsion itself, are all necessary, if a particular constancy is desired in the speed of a given emulsion. The resultant speed of an emulsion depends largely upon the specific heat of the gelatine used. He refers to the influence of the temperature of precipitation upon the resulting colour of a sensitive silver salt when reduced, and shows that a similar influence is exerted when precipitation is effected by means of different compounds. For example, chlorides made from, say, lithium chloride and sodium chloride have different physical appearances as regards colour on exposure. In the case of silver bromide, heat at the time of emulsification produces an effect on the speed of the emulsion, and in the case of both chloride and bromide, physical decomposition (reduction) is accelerated by heat. The author, further, discusses the effect of light itself on silver haloids precipitated in different ways, and furnishes the details of several interesting experiments the results of which have a bearing on emulsion making, particularly in connection with interference colour photography. C. E. A.

1179. *Rotivity of the Homologous Esters of Borneol, Isoborneol, and Camphocarbonic Acid.* **J. Minguin** and **G. de Bollemont.** (Comptes Rendus, 136. pp. 238–240, Jan. 26, 1908.)—The author has measured the rotivities of the stearate, oleate, crotonate, and cinnamate of bornyl, of the formate, acetate, propionate, isobutyrate, butyrate, valerianate, and laurate of isobornyl, and of the methyl, ethyl, propyl, isobutyl, and allyl camphocarbonates. The data give further illustration of the law enunciated by Tchügaeff, viz., that starting from a certain term in the same homologous series, the molecular rotivity is constant. [See Abstract No. 1682 (1902).] D. H. J.

1180. *Rotating Electromagnetic Field Produced by a Helical Modification of the Stratifications in a Vacuum Tube.* **T. Tommasina.** (Comptes

Rendus, 136. pp. 153–155, Jan. 19, 1903.)—On bringing a horseshoe magnet near to one of the electrodes of a vacuum tube and moving it to and fro, parallel to the line joining its poles and to the axis of the tube, it is found that the luminous stratifications seem to go in or out of an invisible case, the mouth of which is about 7 or 8 mm. in front of the electrode. The electrodes, one being an aluminium wire projecting obliquely to the middle of the tube and the other a plane platinum mirror normal to the axis of the vacuum tube, being connected directly to the secondary terminals of the induction coil, each becomes successively anode and kathode, and at each end of the tube is formed a dark space in which faint stratifications can be observed. The author finds that when the mirror is acting as anode for the extra breaking current, a brilliant point appears on the edge of the mirror and projects a luminous spot on the wall of the tube by its side. At the approach of the magnet this spot is repelled or attracted through an angle of 120°, the displacement taking place in a plane parallel to that of the mirror. The luminous point is hence the same as is always seen at the extremity of a linear anode and only makes its appearance at the breaking of the primary current; so that it indicates the plane of maximum anodic emission. On gradually increasing the current, the deviation produced by the magnet also increases, and in some cases the spot effects a complete revolution. On still further increasing the current, the dark space beside the mirror becomes shortened and the luminous spot transformed into a luminous ring, while at the same time the brilliant point disappears, and the whole edge of the mirror increases in brilliancy. Besides this, the stratifications, which had become gradually inclined, recover their original form normal to the axis of the tube. An interior rotation is also visible, as well as a longitudinal pulsation, but the rotation is more rapid and regular. If the current be decreased, this rotation does not disappear until the circuit is broken. By inserting in the circuit, during the rotation, a petroleum discharge so as to eliminate the induced closing current, and by using a weaker and weaker current with very slow interruptions, the anodic luminescence only forms a kind of helical ribbon of which the turns become farther apart while their number diminishes; when there remains but one turn stretching the entire length of the tube, it twists more and more and finally becomes straight when all rotation ceases. Using the wire electrode as anode, the brilliant point is seen to be spherical and situated a little to one side of the end of the wire; it has a sharp contour, although a pulsatory movement is visible throughout its entire mass. In some cases, one or two other points may be seen, but these are less luminous and yellowish. It is also noticeable that either the wire or mirror, when functioning as kathode, is continually being struck on all sides with small particles, producing very brilliant sparks, accompanied sometimes by a small ring-like luminous jet. All these facts seem to confirm the anodic origin of the phenomena observed, and the part which reflection must play in the kathodic modification. If the charges are transmitted along the helical rays, these latter must behave like a solenoid carrying a current. In this case, these rays would turn under the action of the other part of the current which traverses the non-deviating rays, just as a movable solenoid turns round a fixed linear current. T. H. P.

1181. *Spectra of Hydrogen, and Reversed Lines in the Spectra of Gases.* **J. Trowbridge.** (Phil. Mag. 5. pp. 153–155, Jan., 1903.)—In a previous paper the author described experiments on the passage of heavy discharges through glass vacuum tubes [see Abstracts Nos. 33 (1902) and 56 (1903)]; he has recently made use of quartz vacuum tubes which were filled with hydrogen and submitted to a single powerful condenser discharge. The capillary of the vacuum tube was placed up against the slit of the spectroscope, and the spectrum photographed. A continuous spectrum was obtained in the visible region between H and A, but both bright and dark lines were obtained in the ultra-violet region. The principal reversed lines belong to the spark spectrum of silicon, which, the author considers, is another instance of selective polarisation. The strongest metallic or gaseous lines are not those which show the strongest reversal; the reversals of the metallic lines occur when they fall upon bright gaseous lines or bands, and, similarly, a bright gaseous line can show reversal when it falls upon a continuous spectrum. If A is the intensity of the line, and B the amount of the previous action of light upon the plate, then the reversal appears to be proportional to A B. This reversing action on the photographic plate may account for the dark lines in the spectra of some stars. E. C. C. B.

1182. *Relationship between Spectra and Atomic Weights.* **W. M. Watts.** (Phil. Mag. 5. pp. 203–207, Feb., 1903. Communicated by the Physical Society.)—There seem to be two distinct kinds of connection between the spectra of allied elements. In the first class, the differences between the oscillation-frequencies of certain lines of one element are to the differences between the oscillation-frequencies of the corresponding lines of another element as the squares of their atomic weights. To this class belong the families of zinc, cadmium, and mercury, and of gallium and indium. In the second class, the element of greater atomic weight has the smaller oscillation-frequency, and three elements are so related that the differences of oscillation-frequency between the elements, in comparing corresponding lines in their spectra, are proportional to the differences between the squares of the atomic weights. To this class belong the families potassium, rubidium and cæsium, and calcium, strontium, and barium. In both cases it is possible to calculate the atomic weights of elements from the others when the oscillation-frequencies of corresponding lines are known. The convergence-frequencies, that is to say the value of the constant A in Kayser and Runge's formula—

$$\frac{1}{\lambda} = A - Bn^{-2} - Cn^{-4},$$

are in certain cases useful, for the differences between these for two elements are in cases proportional to the differences between the squares of the atomic weights. Examples are given of the accuracy attending the calculation of atomic weights by these relations. The atomic weight of zinc (64·9) is calculated from that of cadmium (111·83), and the mean from sixteen pairs of corresponding lines is 65·37, the extremes being 64·69 and 67·08. The atomic weight of cadmium, from mercury, is found to be 111·44 as a mean from six pairs of lines, the extremes being 109·89 and 113·7. The atomic weight of gallium (69·9) is found from indium to be 69·47 and 69·87 from two pairs of lines. Again, from barium and calcium, the atomic weight of strontium (87·37) was found to be 87·56 as a mean of five close numbers; and finally, the atomic weight of rubidium (85·2) was found from cæsium and potassium to be 84·81, a mean of seven values with extremes 83·11 and 86·87. [The author does not give the mean values in his paper.] E. C. C. B.

1183. *Sensitive-strip Spectropolariscope.* **D. B. Brace.** (Phil. Mag. 5. pp. 161–170, Jan., 1903. Paper read before the American Physical Society at the Pittsburg Meeting, July, 1902.)—The conditions for maximum sensitiveness are the same for a polariscope as for a photometer, the chief one being that the boundary line between the fields to be compared by means of the eye should be perfectly sharp and should vanish with equal illumination, when the tint becomes the same over the whole field of view. The author has applied his sensitive-strip method [see Abstract No. 53 (1900)] to the spectropolariscope with considerable success; the arrangement is as follows: A plate of calcite about 2 mm. thick is placed diagonally in a glass tube fitted with plate-glass ends and filled with α-monobromonaphthalene; the beam of light enters this cylinder and, as it meets the calcite plate at an incident angle of 70°, only the ordinary ray is transmitted; this is due to the fact that the value of μ_0 for calcite is 1·6584 for the D-line, and of μ for the same line with α-monobromonaphthalene is 1·6582. In the same or a second similar cylinder, a narrow strip of calcite, 5 mm. wide and 0·15 mm. thick, is placed so as to trisect the field. When this system is examined in the ordinary way with an analyser and telescope, a surprising sharpness is observed between the fields and, with a neutral setting, a perfect vanishing line is obtained. E. C. C. B.

1184. *Abnormal Changes in the Spectrum of Lithium.* **H. Ramage.** (Roy. Soc., Proc. 71. pp. 164–171, Jan., 1903.)—A series of visual and photographic observations of the lithium spectrum, undertaken with a view of explaining certain discrepancies between the wave-lengths of the lines as determined by the author in the flame spectrum and by Kayser and Runge in the arc; these discrepancies are especially marked in the case of lines which belong to the first subordinate series. The spectrum given by lithium carbonate in the arc between carbon poles was examined, and the following conclusions were drawn. The lines in the principal series appear to broaden and reverse normally. The lines in the second subordinate series do not reverse, but in strong arcs they broaden towards the less refrangible end of the spectrum and become diffuse on that side. The first line in the first subordinate series $\lambda = 6103{\cdot}84$ is almost normal; it broadens slightly, more on the more refrangible side. The other lines of this series also broaden on both sides and become diffuse, but they broaden more rapidly on the more refrangible side. The inner core of intense arcs, and the parts near the negative poles of weak arcs and sparks, give a broad reversed line with its centre about $\lambda = 4602{\cdot}4$; whilst the part near the positive pole of weak arcs and the flame of the arc give a sharp bright line at $\lambda = 4603{\cdot}07$, coincident with the lines in the spectra of the oxyhydrogen flame and uncondensed sparks. The similar changes in the other lines diminish with their refrangibility. The wave-lengths hitherto recorded for these diffuse lithium lines thus appear to be those of abnormal lines. The true lines are the sharp bright ones which occur, without complication, in the spectrum of lithium in the oxyhydrogen flame. In conclusion, the author doubts Hagenbach's results on the duplicity of the line at $\lambda = 4603$ for the reasons given above. [See Abstract No. 716 (1903).] E. C. C. B.

1185. *Spark Lines in Arc Spectra.* **J. Hartmann** and **G. Eberhard.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 4. pp. 40–42, Jan. 22, 1903.)—Following on Konen's experiments upon the spectrum of the arc under water [see Abstract No. 633 (1903)], the authors have particularly investigated the spectra of magnesium and silicon under these conditions. They find that in the spectra of the arc the characteristic spark lines make their appearance; thus for example, the spark lines of silicon at $\lambda = 4128$ and $\lambda = 4131$, and the line of magnesium at $\lambda = 4481$, are as intense as the most important arc lines.

In the case of magnesium, the line $\lambda = 4481$ is the brightest in the whole spectrum. The same phenomenon is to be seen in the case of zinc and cadmium. Thinking it possible that the lower temperature of the electrodes might be the reason, the authors examined the spectrum of zinc at temperatures increasing from that of liquid air to the melting-point of the metal, and then found that the relative intensity of the arc to the spark lines increases with the temperature. While this may be due to an increased amount of metallic vapour in the arc, these results show that it is not permissible to draw definite conclusions as to the temperature of the discharge. Especially must we be careful not to make positive assertions regarding the temperature of the stars from the presence of certain magnesium and silicon lines in their spectra. E. C. C. B.

1186. *Peculiarities and Alterations of Fraunhofer Lines.* **W. H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 650–663, Feb. 28, 1903.)—Jewell's experiments on the coincidence of Fraunhofer lines with emission lines of metals [see Abstract No. 1794 (1900) and Astrophys. Journal, 3. p. 89 (1896)], have especially drawn attention to the fact that the solar spectrum is not constant, the departures stated being relative to the *mean* sunlight. In accordance with the Doppler principle, displacements of the lines should be anticipated as a consequence of the rotation of the sun, the rotation of the earth, and the variation in the distance between the earth and the sun, on account of the eccentricity of the orbit of the former. When taking into account all these circumstances there will, however, still remain some irregularities. In the first place, there are some Fraunhofer lines coinciding accurately with emission lines of the arc spectrum of the element, whereas the coincidence of other lines is not an exact one, the displacement being different, not only for lines of different elements, but even for those of the same element; moreover, the intensity of some lines was found by Jewell to undergo occasional variations. Far greater departures are observed in abnormal solar spectra, such as described by G. E. Hale (Astroph. Journ. 16. p. 211, 1902).

The author thinks these phenomena to be due to the path traversed by light between the sun and the earth. As on this path there are substances exhibiting anomalous dispersion, the composition of the beam of light will be modified. As shown by the author in a former paper [see Abstract No. 881 (1903)], the properties of chromospheric light may be explained on the hypothesis that this is separated from the photospheric light by anomalous dispersion. Now the author thinks the same classes of radiations play a special part in connection with abnormal solar spectra. In order to test this, a number of lines evidently weakened were recorded, a comparison of which with corresponding lines in normal solar spectra would readily give the values of the wave-length; the same was done with regard to strengthened lines. From a comparison with Hale's and Lockyer's values for the intensity of corresponding lines in the chromospheric spectrum, the conclusion is drawn that the weakened lines are, almost without exception, chromospheric lines, whereas most of the strengthened lines do not occur in the chromosphere spectrum. It is further shown that, provided the earth is just in the prolongation of an equatorial projection from the corona at the moment the abnormal spectrum is being photographed, all the departures observed in that spectrum may be accounted for. Some light, eliminated as a rule from the solar spectrum on account of great diffusion, would be concentrated by the corona projection, this resulting in the

Fraunhofer lines being weakened. The rarity and short duration of the phenomenon would seem to be due to the remoteness of the chance of taking a photograph at the very moment of a corona projection extending just in the direction of the sun. A satisfactory explanation of the strengthening of some lines is obtained by the hypothesis that the absorption line in question will give rise to an anomalous dispersion of neighbouring waves (to a very limited extent), when the refractive indices of the neighbouring waves will be little different from unity, the rays undergoing a variation in direction, appreciable only after a very long wave has traversed the corona. As regards the peculiarities of lines in the normal solar spectrum, the author thinks only the dark cores of Fraunhofer lines to be due to real absorption, whereas the background of variable intensity is considered, as a consequence of anomalous dispersion of the neighbouring wave-lengths, as not absorbed. A. G.

1187. *Fluorescence of Naphthalic Anhydride.* **J. T. Hewitt.** (Soc. Chem. Ind., Journ. 22. pp. 127–128; Discussion, p. 128, Feb. 16, 1903.)—The author in 1900 proposed the theory that the fluorescence of organic compounds depends on the possibility of tautomerism, and he contends that the suggested explanation will, on fuller examination, be found to apply to the case of naphthalic anhydride and its derivatives, although Francesconi and Bargellini, who investigated the subject, came to the opposite conclusion.

D. H. J.

1188. *Velocity of Propagation of Röntgen Rays and of Light.* **R. Blondlot.** (Archives des Sciences, 15. pp. 5–29, Jan., 1903. Communication made to the Physics Section of the Société Helvétique des Sciences Naturelles, Sept. 9, 1902.)—This is an account of the work carried out by the author, and already described in abstracts of the papers published in the Comptes Rendus [see Abstracts Nos. 426, 686 and 1194 (1903)], with the addition of a photograph of the apparatus used and a short appendix describing some details of portions of the apparatus, such as the induction coil, the exciter, and the resonator.

J. J. S.

1189. *Absorption of Gravitational Energy by Radio-active Substances.* **R. Geigel.** (Ann. d. Physik, 10. 2. pp. 429–435, Jan. 27, 1903.)—A ball of lead, weighing 6·5 grams, seems to lose 0·035 mg. of its weight when a gram of radio-active substance is brought under it. The apparent loss of weight is greater if the radio-active substance has been freshly shaken up. The cause does not seem to lie in upward bombardment of the lead by particles from the radio-active substance, for the smaller the free surface of the latter the greater the apparent loss. On the other hand, equal quantities of radio-active substance produce different effects according to the vertical thickness of it; a particular thickness gives a maximum, on either side of which the material becomes thinner or falls away in horizontal area. This points to absorption of gravitation effect by the radio-active substance placed across the lines of gravitational force, and this would indicate absorption of gravitational energy by the radio-active substance. If the radio-active substance be covered with tinfoil there is a slight increase in the apparent weight, which seems to be due to electrostatic effects. A. D.

1190. *Magnetic Deviability of Certain Rays sent out by Radium.* **H. Becquerel.** (Comptes Rendus, 136. pp. 199–203, Jan. 26, 1903.)—A confirmation of Rutherford's results [see Abstract No. 428 (1903)] was obtained by a photographic method. The radio-active substance was placed in a groove hollowed out in a block of lead. Above this, at a height of about 1 cm., was arranged a metallic screen with a slit in it parallel to the groove, and above this again a photographic plate. The whole was put in the field of an electromagnet, the slit being parallel to the field. When the magnetic field was excited first in one sense and then in the other, two images of the beam were obtained on the proof, which shows that the pencil of rays was deviated first in one direction and then in the other. In one case, a distance between the images of 1 mm. was obtained. Further experiments showed that the direction of the deviation agreed with the results obtained by Rutherford. J. J. S.

1191. *Deviation of Radium α-Rays.* **E. Rutherford.** (Phil. Mag. 5. pp. 177–187, Feb., 1903.)—The α-rays are here dealt with. They are easily absorbed by aluminium-foil, but are hard to deviate. The radium used was specially powerful, having an activity of 19,000. The apparatus is as follows: Above the radium comes a pile of parallel layers of aluminium-foil, the spaces between the foils being about 1 mm. A magnetic field is put on, having its lines of force parallel to the foil and perpendicular to the motion of the rays, so that, when deviated by the field, the rays pass into the layers of foil and are more or less absorbed. But any rays which escape the aluminium pass out of the pile through a very thin aluminium sheet to an electroscope, and, as these α-rays produce great ionisation, they cause movement of the electroscope. A slow stream of dry hydrogen is sent against the motion of the rays so as to carry back any emanation of the radium, which, if present, would produce large ionisation on its own account and confuse the results. The experimental result is that deviation is proportional to the field. It is shown independently that the α-rays are positively charged; this is done by partly covering up the slits either on the right or on the left; if on the right, then if the rays are deviated to the right, there will be an increased absorption, and so on.

The rays were also deviated electrostatically. This was done by charging alternate layers of the foil to 600 volts, and maintaining the others at zero potential. It was found that by this means the rate of discharge was reduced by 7 per cent. The velocity of the rays was found $V = 2{\cdot}5 \times 10^9$ c.g.s. by the usual means [see Abstract No. 428 (1903)]. P. E. S.

1192. *Further Experiments on Radio-activity from Rain.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 12. p. 17, Jan. 28, 1903.)—A continuation of investigations previously published [see Abstract No. 310 (1903)]. A vessel in which freshly fallen rain has been evaporated to dryness, shows radio-active properties lasting a few hours only. From many samples tested since the first cases described, it is found that the magnitude of the effect is nearly always of the same order, even when the conditions under which the rain is collected are varied. Heating the vessel to dull redness does not destroy the radio-activity. A radio-active precipitate is got from freshly fallen rain by adding a small quantity of alum to the rain water and then precipitating the aluminium as hydrate by means of ammonia. The hydrate thus obtained gives greater effects than by evaporating the rain alone. J. J. S.

1193. *Excited Radio-activity.* **E. Rutherford.** (Phil. Mag. 5. pp. 95–117, Jan., 1903.)—This paper contains a summary of results previously obtained and published [see Abstract No. 1063 (1902)], and also notes upon further observations on excited radio-activity and the method of its transmission. The view has previously been put forward that radio-activity is an accompaniment of continuous chemical change, and the following is the summary of the results arrived at by the author. (1) Excited radio-activity produced by thorium and radium compounds is due to the deposit of radio-active matter which is derived from the emanation given out by these bodies. (2) Excited radio-activity is transmitted by positively charged carriers, produced from the emanation, which travel in an electric field with about the same velocity as the positive ions produced in air by Röntgen rays. This velocity (about 1·3 cm. per sec. for 1 volt per cm.) is about the same for the carriers of thorium- and radium-excited activity. (3) These positively charged carriers are due to the expulsion of a negatively charged body from the molecule of the emanation. (4) Evidence is adduced for the view that the easily absorbed and apparently non-deviable rays of radio-active substances are due to the expulsion of charged bodies at a high velocity. The rays are thus analogous to the *Canal Rays* of Goldstein, which Wien has shown to be positively charged bodies projected at a great speed. In the case of the emanations, the expelled particles are for the most part negative in sign. (5) In the case of radium, about 5 per cent. of the carriers of excited radio-activity are distributed on the anode in a strong electric field. (6) The excited radiations from thorium, due to a short exposure in the presence of the emanation, increase, in the course of several hours after removal, to three or four times their initial value. (7) The emanations and the matter which gives rise to excited activity are the result of a succession of chemical changes occurring in radio-active matter. In thorium there is evidence of at least four distinct chemical changes. J. J. S.

1194. *Velocity of Different Varieties of Röntgen Rays in Air and other Media.* **R. Blondlot.** (Comptes Rendus, 135. pp. 1293–1295, Dec. 29, 1902.)—Different penetrating powers are observed in the case of Röntgen rays according as the exhaustion in the tube whence they proceed is carried to a less or greater extent. In this note an account is given of the direct comparison of the velocity of light with that of Röntgen rays of various penetrating powers, by means of the methods already described by the author [see Abstracts Nos. 426, 635, 636, and 1188 (1903)]. The conclusion arrived at is that the different kinds of Röntgen rays travel with the same velocity, and that, within the limits of the conditions and of the errors to which the method used is liable, this velocity of propagation is the same as that of light in air. J. J. S.

1195. *Stereoscopic Radioscopy.* **T. Guilloz.** (Soc. Franç. Phys., Séances, 1. pp. 52–56, 1903.)—Apparatus for shifting the focus tube from one side to the other, and a corresponding shutter for shutting off vision while the focus tube is being shifted, and for allowing one eye only to view the screen while the focus tube is in either of its extreme positions. This displacement may be effected as seldom as once per sec. if the observer can allow both eyes to act equally; but if he has a tendency to use the eyes separately, increasing the frequency of the shift to 3 or 5 per sec. will overcome this, and the persistence of vision will give a clear stereoscopic picture. This gets rid of difficulties arising from inequalities in the two focus tubes usually employed. [See Abstract No. 2217 (1902).] A. D.

HEAT.

1196. *Optical Pyrometer.* **L. Holborn** and **F. Kurlbaum.** (Ann. d. Physik, 10. 2. pp. 225–241, Jan. 27, 1903. Communicated by the Physikalisch-Technische Reichsanstalt.)—The authors' optical pyrometer, consisting of a telescope with a glow lamp between objective and eyepiece [see Abstract No. 2122 (1901)], is again described, and details are given with regard to the construction of the instrument, its standardisation and working. The 4-volt lamps employed became sufficiently constant after being kept burning at 4 volts for 30 hours and being thus kept at a temperature of about 1,900°. Prism systems are employed for reflection when the intensity of the luminous source is greater than that of the glow lamp. The results of the use of the instrument in determining the melting-points of platinum and palladium are given, strips of these metals being electrically heated up to their melting-points, the values found being expressed in terms of the corresponding temperatures of the standard black body, when emitting an equal amount of light. [See also Abstract No. 1320 (1902).] G. E. A.

1197. *Dilatation of Tempered Steel.* **G. Charpy** and **L. Grenet.** (Comptes Rendus, 136. pp. 92–94, Jan. 12, 1903.)—The authors have examined the effect of tempering on the dilatation of steel. Small specimens were used, so that in tempering they could be chilled very rapidly: the results hold only for such rapid chilling. From the data it appears that (1) in the case of soft steels (0·5 per cent. of C), tempering does not affect the coefficient of dilatation, whatever be the temperature to which the steel is heated for purposes of tempering. (2) In the case of medium steels (0·6 to 1 per cent. of C), a similar result is obtained where oil is used. In the case of water, however, the temperature to which the steel is heated must not exceed 900°, otherwise the curve of dilatation shows a sharp change, corresponding to a contraction of about 0·1 per cent. between 250° and 350°. (3) A similar result to (2) holds for high carbon steels, except that tempering by heating above 900° and chilling in water leads to a dilatation curve showing two contractions (at about 150° and 300°). [See also Abstracts Nos. 1321 and 1747 (1902).] D. H. J.

1198. *Conductivity of Argon and Helium.* **W. Schwarze.** (Phys. Zeitschr. 4. p. 229, Jan. 15, 1903. Communication from the Physikal. Instit. der Universität, Halle a. S.)—The corrected values for the conductivity of air and argon at 0° C. are 0·00005690 and 0·00003894 respectively, and the latter gives the value 2·501 for f in the formula $k = fc\eta$, which connects the conductivity with the isometric specific heat and the viscosity. The conductivity for helium (with a slight impurity of neon) is 0·0003386, and this with Schultze's value 0·00001891 for the viscosity [see Abstract No. 10 (1902)] gives $f = 2·490$. Thus for monatomic gases the value of f seems to be 2·5, though Neugebauer's theoretically calculated value is 1·6027. R. E. B.

1199. *Conductivity at Low Temperatures.* **E. Giebe.** (Deutsch. Phys. Gesell., Verh. 2. pp. 60–66, Jan. 30, 1903.)—Grüneisen's modification of Schulze's method [see Abstracts Nos. 803 (1899) and 9 (1901)] was employed with a cylindrical rod of pure bismuth, 15 cm. long and 1·8 cm. thick, at temperatures 18°, − 79° and − 186° C. Theoretically, the temperature u at time t at a point distant z from the warmed or cooled face is given by—

$$u = 2\mathrm{C}(t/\pi ck)^{\frac{1}{2}}\left(e^{-a^2} - 2a\int_a^\infty e^{-a^2}da\right)$$

where $a \equiv z/2(kt/c)^{\frac{1}{2}}$, k being the conductivity, c the specific heat per unit volume, and C the practically constant flow into the face. It was found, however, that, the theoretical conditions not being sufficiently fulfilled, the observations for different values of z were not reconcilable with the formula unless in the value of a, the distance z were increased by a small constant length ζ, dependent on the temperature of the face. Thus were found in C.G.S. units—

at 18° C,	$\zeta = 0{\cdot}05$,	$k = 0{\cdot}0192$,	$k/\kappa = 2230$
− 79°	0·126	0·0252	2110
− 186°	0·35	0·0558	2280

where κ denotes the electrical conductivity as determined by Dewar and Fleming. This constancy of the ratio k/κ, though not in agreement with Lorenz' law, is borne out by Jäger and Diesselhorst's measures. R. E. B.

1200. *Dilatation of Nickel-Steels.* **C. E. Guillaume.** (Comptes Rendus, 136. pp. 303–306, Feb. 2, 1903.)—This continues the previous work upon these alloys [see Abstracts Nos. 1133 and 1134 (1903)]. The production of the alloys of small expansion depends upon the auxiliary substances, *e.g.*, manganese, carbon, silicium. The author has succeeded in obtaining an alloy of such small thermal variation that its amount cannot be measured with certainty. A wire 1 km. long would change by 0·4 mm. between 0° and 20°. The expression for the coefficient (which shows the expansion range, the contraction range, and the critical temperature) is $(0{\cdot}028 - 0{\cdot}00232\,\theta)10^{-6}$. A table of values for various alloys between 0° and 38° is given. J. W. P.

1201. *Rise of the Zero Point of Jena Glass Thermometers.* **W. Schloesser.** (Zeitschr. Instrumentenk., Beib. 1. pp. 2–3, Jan. 1, 1903.)—The glass whose behaviour is described is referred to as Jena glass 16$^{\mathrm{III}}$. The condition of the zero point depends upon the temperature at which the thermometer was constructed and on its age. The age effect is found to be—changes of 0·042°, 0·056°, 0·066°, after five, ten, and fifteen years respectively. Comparisons with results for French hard glass, by Guillaume, are given. [See also Abstract No. 308 (1902).] J. W. P.

1202. *Variation of the Critical Velocity of Water with Temperature.* **E. G. Coker** and **S. B. Clement.** (Roy. Soc., Phil. Trans. 201. pp. 45–61, March 23, 1903. Roy. Soc., Proc. 71. pp. 152–153, Jan. 1903.)—After referring to the earlier work of Reynolds, in which the temperature range was very limited, the present experiments and their special difficulties, owing to the wider range of temperature, are described. The range taken is from 4° to 50°, as this seemed sufficient to test the law and yet not so great as to introduce large conduction and radiation errors. The resistance method employed by Reynolds is here used, with additions, such as pressure chambers, giving a continuous opening at the ends of the pipe examined, an inverted U-tube for measuring pressures, and the weighing of the discharge. Stream-line motion being maintained in the pipe at the different temperatures, the relation of velocity to pressure-slope is determined. The lines plotted from those results agree with those got theoretically from the equations of motion. Similar lines being got for eddy motion, the intersections of corresponding pairs give the minimum critical velocity. As a conclusion, it is found that in small pipes the critical velocity varies directly as the viscosity. J. W. P.

1203. *Heats of Formation of Nitrogen and Sulphur Compounds.* **M. Delépine.** (Comptes Rendus, 136. pp. 451–453, Feb. 16, 1903.)—By means of the Berthelot calorimetric bomb, the author has determined the heats of formation of a number of bodies: (1) Substances of the type RN: C.(SR′)$_2$; (2) isomeric substances of the type R′$_2$N . CS . SR; (3) thialdines isomeric with bodies under (1) and (2); (4) carbo-thialdines. It appears that the heat of formation of a body belonging to group (1) is always much less than that of the isomer belonging to group (2). From the present data and those for the corresponding isocyanic esters, we may infer that the group $(CH_3)_2S$ corresponds to a difference of 11·1 cal. in the molecular heat of formation of a compound into which it enters. D. H. J.

1204. *Thermic Properties of Solids and Liquids.* **S. Lussana.** (N. Cimento, 5. pp. 153–179, March, 1903.)—In phosphorus and α-naphthol the compressibility in the solid state as well as in the liquid diminishes with increased pressure. If the volume V be taken as $a + bp + cp^2$, b is always negative and c positive, and both b and c increase with the temperature, and are much greater in the liquid than in the solid state. The coefficient of dilatation diminishes with increase of pressure. In the superfused state these substances act as liquids; and it appears that superfusion is easier the higher the pressure. The variation of volume during fusion diminishes with increase of pressure, in a ratio which continuously decreases. A. D.

1205. *Thermodynamical Correction of the Gas-thermometer.* **H. L. Callendar.** (Phil. Mag. 5. pp. 48–95, Jan., 1903. Paper read before the Physical Society, March 26, 1901.)—Observation shows that the "cooling-effect" of a gas is independent of its pressure; this, combined with the observed shape of its isothermals, leads to the conclusion that the characteristic at moderate pressures is of the form $v - b = R\theta/p - c$, where the co-volume b is constant and the coaggregation-volume c is a function of the absolute temperature θ only. Assuming c to vary inversely as θ^n, the value of n is different for different types of coaggregation or for different kinds of molecules, and it may be interpreted as half the number of degrees of freedom lost by a molecule in coaggregation, being probably 0·5 for monatomic gases, 1·5 for diatomic gases, 2 for CO_2, and 3·3 for steam. The law of corresponding states must be restricted to molecules of the same type which coaggregate in a similar manner. Lastly, the value of the absolute zero (which, as deduced from the pressure-coefficient of hydrogen, is probably $-273·1° \pm 0·02°$ C.) may be approximately found from a knowledge of the cooling-effect and the specific heat at about 50° C. without any knowledge of their mode of variation with temperature, but this last knowledge is essentially needed for the determination of the scale-correction of the gas-thermometer. R. E. B.

1206. *Absolute Temperature deduced from a Normal Thermometer.* **H. Pellat.** (Comptes Rendus, 136. pp. 809–811, March 30, 1903.)—Temperature on a constant-volume gas-thermometer being defined by $p = p_0(1 + at)$ where $100a \equiv p_{100}/p_0 - 1$, we have $p + \partial_t E/\partial v = T\partial_v p/\partial T = apT(1 + at)^{-1}\,dt/dT$, E being intrinsic energy, whence $a(1 + at)^{-1}\,dt = (1 + K)dT/T$, where

$K \equiv p^{-1}\partial_t E/\partial v$. For hydrogen and other gases K is positive, and, if we take it to be constant, integration gives $T/T_0 = (1 + at)^{1/(1+K)}$, and $1 + 100/T_0 = (1 + 100a)^{1/(1+K)}$, so that approximately $T \bumpeq (1 + K)a^{-1} + t$. Hence T_0 is always greater than a^{-1}, and the greater a is for a gas the greater also is K. If $K \equiv A/T$, where A is constant, then $\log(T/T_0) - A(T^{-1} - T_0^{-1}) = \log(1 + at)$ or approximately $T \bumpeq A + a^{-1} + t$. This value of K corresponds to a characteristic of the form $p/te^{-A/t} = f(v)$, of which van der Waals' equation is an approximate form; and from the van der Waals characteristic for hydrogen, A appears to be about 0·11. R. E. B.

1207. *Influence of Radiation on Heat-transmission.* **A. Schuster.** (Phil. Mag. 5. pp. 243–257, Feb., 1903.)—A theory is given from which results as the equation for the flow of heat through a uniform plate with the isothermal surfaces parallel to its bounding faces—

$$(\partial^2/\partial x^2 - \kappa^2)(c\,\partial u/\partial\theta - \lambda\partial^2 u/\partial x^2) + 2\kappa\partial^2 F/\partial x^2 = 0,$$

where κ denotes the emissivity, λ the conductivity, c the specific heat per unit volume, u the temperature at the depth x, θ time, F the total radiation sent out in all directions per unit time per unit area of a perfectly black body. In the case of steady temperatures of a non-conducting and partially transparent plate of thickness t, placed with its surfaces in contact with two other surfaces which have reflecting powers σ, and are kept at constant but different temperatures so that their radiations are F_0 and F_1 respectively, the theory gives $F = K\kappa x + c$, where—

$$K/(1-\sigma)(F_1 - F_0) = c/\{(1+\sigma)(F_1+F_0) + (1-\sigma)\kappa t F_0\} = 1/\{(1-\sigma)\kappa t + 2(1+\sigma)\},$$

so that discontinuities of F equal to $(F_1 - F_0)(1 + \sigma)/\{(1-\sigma)\kappa t + 2(1 + \sigma)\}$ occur at both boundaries. [In the paper there are slips in the equation for F and in the calculation of K and c, which, however, do not affect the result.] For perfectly black bounding surfaces $\sigma = 0$; for perfect reflectors $\sigma = 1$. These discontinuities show that λ must be taken into account in any real case; for steady temperatures the equation of flow then becomes $\partial^4 u/\partial x^4 = (\kappa^2 + 2\kappa R/\lambda)\partial^2 u/\partial x^2$, the solution of which is $u = Pe^{ax} + Qe^{-ax} + Mx + N$, where $a^2 \equiv \kappa^2 + 2\kappa R/\lambda$ and P, Q, M, N are constants determinable from the boundary conditions: and the negative flow of heat per unit area through any isothermal plane is $M\lambda a^2/\kappa^2$. Curves are drawn for the steady temperatures of a plate, 5 cm. thick, with an absorption-coefficient 0·64 equal to that of rock-salt, and a thermal conductivity 0·00013 equal to that of cork when its average temperature is about 30° and 360° C., and when the boundaries are totally reflecting and black. They show that radiation destroys the uniform temperature-slope which is obtained when conductivity alone is taken into account, and that the deviations from uniformity are greater when the surfaces are reflecting than when they are black. The effect of scattering and irregular reflections is also considered, as well as the ratio of the total radiation of a surface to its normal radiation. It would seem that in the absence of absorption but with the presence of scattering the temperature-gradient is constant. R. E. B.

1208. *Theoretical Radiation-Scale of Temperature.* **O. Lummer** and **E. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 1. pp. 3–13, Jan. 15, 1903. Communication from the Physikalisch-Technische Reichsanstalt.)—The method proposed by the authors [see Abstract No. 307 (1902)] has been tested at exceedingly high temperatures, and the readings made with a Lummer-Kurlbaum flat bolometer, a Schmidt-Hänsch spectrobolometer, and a Lummer-Brodhun spectrophotometer, lead to estimations of a particular high temperature, which are on the average respectively 2,320, 2,333, 2,325 abs., when they are reduced by use of the constants determined for the instruments at lower temperatures measured thermoelectrically or directly by a gas thermometer (*i.e.*, below 1,150° C.). This very close agreement may be taken as a proof of the exactness of the laws of radiation cited in the above Abstract.

It further shows that we may define a scale of temperature in terms of the radiation of a black body, and that this will be an absolute one, as the radiation is independent of the nature of the black body; also that, if the temperature is taken as proportional to the fourth root of the total radiation and such that the temperature-difference between the freezing- and boiling-points of water is 100, this scale will agree with that of the gas-thermometer. [See Abstract No. 713 (1903).] R. E. B.

1209. *Generalisation of Carnot's Cycle.* **S. A. Moss.** (Phys. Rev. 16. pp. 28–34, Jan., 1903.)—Draw a *line of constant specific heat* for any given value $\mathfrak{C}$ of the specific heat of the working substance considered: through any points A, D upon it corresponding to temperatures T_0, T_3 draw adiabatics which cut respectively in B, C (corresponding to T_1, T_2) any other line of constant specific heat for the *same* value $\mathfrak{C}$. Then the efficiency of a cycle consisting of adiabatic compression along AB, expansion along BC at constant specific heat, adiabatic expansion along CD, and compression along DA at the same constant specific heat as in BC, is $1 - T_0/T_1$ whatever may be the values of T_2 and T_3. For we have—

$$0 = \int dH/T = \mathfrak{C}\int dT/T = \mathfrak{C}\left\{\log(T_2/T_1) + \log(T_0/T_3)\right\}$$

or $T_2/T_1 = T_3/T_0$, and thus the efficiency—

$$\equiv 1 + \int_3^0 dH \Big/ \int_1^2 dH = 1 - (T_3 - T_0)/(T_2 - T_1) = 1 - T_0/T_1.$$

Carnot's is a particular case of this more general cycle since isothermals are lines of infinite specific heat. For solids the isopiestics are approximately lines of constant specific heat, and indeed for practically the same value of the specific heat. For a perfect gas with characteristic $pv = Rt$ and constant isometric specific heat k, all lines $pv^n =$ constant, where n is a given constant, are lines of constant specific heat corresponding to the specific heat $k + R/(1 - n)$; these lines are isopiestics for $n = 0$, in which case the cycle is that of Joule's air-engine. R. E. B.

1210. *Fan-system of Heating.* (Eng. Record, 47. p. 325, March 28, 1903.)—This records tests, made by R. C. Carpenter, of a cast-iron heating surface used in connection with a blower fan for heating the air. Curves are drawn to show the relations between (1) the speed of the fan and the mass of steam condensed for different areas of the heating surface, (2) the mass of steam condensed per square foot of heating surface and the volume of air discharged by the fan for different areas of heating surface. They show that the advantage of increasing the number of heaters beyond a certain number (4 heaters or 16 pipes in the actual arrangement used) is only slight. R. E. B.

1211. *Thermo-chemistry of Alloys of Copper and Aluminium.* **W. Louguinine** and **A. Schükarew.** (Archives des Sciences, 15. pp. 49–77, Jan., 1908.)—The authors have determined the heats of formation of alloys of copper and aluminium, containing less than 50 per cent. of aluminium, by utilising the solubility of the alloys in a solution of bromine in aqueous potassium bromide. Unfortunately the method is not applicable to alloys containing more than 50 per cent. of aluminium, as these show secondary reactions when treated with the bromine solution; thus it was not possible to determine the heats of formation of the two crystalline Cu-Al alloys, viz., $CuAl_3$ and Cu_4Al_9, of which the former was prepared by the authors for the first time. The results in calories for 1 gram of alloy were: Cu_3Al, 123·5 cal.; Cu_2Al, 137·9; Cu_3Al_2, 71·0; CuAl, 20·8; Cu_2Al_3, 48·9; $CuAl_2$, —57·2. [See also Abstract No. 913 (1902).] D. H. J.

1212. *Vapour Pressures and Boiling-points of Mixed Liquids.* **S. Young** and **E. C. Fortey**. (Chem. Soc., Journ. 83. and 84. pp. 45–68, Jan., 1908.)—For two liquids for which the critical pressures are equal, viz., chlorbenzene and brombenzene, one of the authors has experimentally verified the formula $P = pP_A + (100 - p)P_B/100$ to express the vapour pressure of a mixture of two liquids A and B; P, P_A, and P_B are here the vapour pressures of the mixture and constituents, p is the molecular percentage of A. The formula is not necessarily valid only for liquids of the same critical pressure, and the authors, for the present investigation, have chosen four pairs of liquids, viz., (1) ethyl acetate and ethyl propionate, (2) toluene and ethyl benzene, (3) *n*-hexane and *n*-octane, (4) benzene and toluene, for which the critical pressures are very different, although the substances are closely related. Mixtures of carbon tetrachloride and benzene were also examined. In all cases observations were made of thermal and volume changes consequent on mixture of the experimental liquids. The authors conclude as follows: 1. The volume and temperature changes on mixing closely related substances are, in all the observed cases, very small, but it is only with chlorobenzene and brombenzene that they can certainly be said to be within the limits of experimental error. With the two esters these limits are very closely approached, whilst with benzene and toluene, which are somewhat less closely related, the changes are distinctly larger, and for mixtures of benzene with *n*-hexane and with carbon tetrachloride, they are very much larger; (2) the formula given above is very nearly, if not quite, true for closely related liquids, even when the critical pressures are widely different; it is not generally true, however, for mixtures of liquids of normal molecular weight, such as benzene and *n*-hexane or benzene and carbon tetrachloride, which are not closely related, although Zawidski has shown that the formula does hold good for benzene and ethylene dichloride. [See also Abstracts Nos. 2222 (1902) and 141 and 1027 (1908).] D. H. J.

1213. *Heat Convection in a Vertical Cylinder.* **L. C. de Coppet**. (Annal. Chim. Phys. 28. pp. 145–218, Feb., 1908.)—The experiments here described are a continuation of the work on the maximum density point of water, published in 1894. The cylinder is now made of copper, it is 28 cm. high and 81 mm. external diameter. It is filled with water and is heated or cooled on the lateral surface. The heat convection is observed thermometrically, and the maximum density point of water is determined with high accuracy. A full description of the fourteen thermometers used is given, and the values of their readings for the successive epochs of the heating or cooling are tabulated. The maximum density point is given as 4·006°. J. W. P.

1214. *Specific Heats of Air and Steam.* **W. Makower.** (Phil. Mag. 5. pp. 226–238, Feb., 1908. Communicated by the Physical Society.)—The gas under investigation is allowed to expand adiabatically, and the lowering of temperature so caused is measured. The pressures are measured on an oil manometer, and the temperatures by a platinum thermometer with compensating leads. Temperatures were read to 0·01° C., and the quantity of air experimented upon was about 50 litres. The value of the ratio of specific heats for air is found to be 1·401. For steam, a much smaller vessel (9·3 litres) was used. The ratio is found to be 1·307 and 1·308; for times of expansion 0·67 and 0·50 sec. respectively. J. W. P.

1215. *Animal Thermostat.* **Kelvin.** (Phil. Mag. 5. pp. 198–202, Feb., 1908. Paper read before Section A of the British Association at Belfast.)—Emphasis is laid upon the need of further observations on the average temperature of healthy persons living in a thoroughly moist atmosphere at temperatures considerably above 98·4°. The experiments of Adair Crawford performed in 1780 (Hutton's "Abridgements," vol. xv., p. 147) are quoted, by which this observer made the important discovery that the venous blood of a dog which had been kept for some time in a hot-water bath at 112° F., and whose temperature had remained normal, was almost indistinguishable from its arterial blood. Since the venous blood must have contained much less than the normal amount of carbonic acid or even none at all, it seems that the breath of an animal under such conditions may be found to contain no carbonic acid, or even a surplus of oxygen. The author suggests that possibly the body temperature is maintained at its normal level by a process of deoxidation of matter in the body, and that this matter may be water, in which case the breath would probably be found to contain free hydrogen. H. W. P. Y.

1216. *Animal Thermostat.* **A. Chauveau.** (Comptes Rendus, 136. pp. 792–798, March 30, 1908. A reply to Kelvin's communication [see preceding Abstract].)—The author found that warm-blooded animals, placed in a bath at a temperature considerably above that of the normal temperature of the animal, very quickly succumb, and that the venous blood just before death becomes very dark in colour and contains scarcely any oxygen. If, however, blood be drawn from the veins shortly after the animal is placed in the bath, the colour is bright red and almost indistinguishable from that of arterial blood. Analysis of the gases show that there is no loss of carbonic acid and no gain of oxygen during the passage of the blood through the tissues. Moreover, the respiratory coefficient is not altered by the bath. He concludes that the arterial nature of the venous blood is due merely to the fact that the capillaries are dilated by the heat so that the passage from the arteries to the veins is much more rapid. Not only is there no inhibition of the phenomena of intra-organic combustion, but there is often, if not always, an augmentation of the process which must be measured, not only by the percentage of the gaseous interchange, but also by the quantity of oxygen-bringing blood traversing the tissues. H. W. P. Y.

REFERENCE.

1217. *Water-value of a Berthelot Calorimeter.* **W. Jaeger** and **H. v. Steinwehr.** (Deutsch. Phys. Gesell., Verh. 2. pp. 50–59, Jan. 30, 1908. Communication from the Physikalisch-Technische Reichsanstalt.)—A description of an electrical method employed to determine the water-value of a particular instrument, with a deviation from accuracy of not more than 0·15 per cent. R. E. B.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1218. *Scattering of Electricity in Enclosed Spaces.* **E. Riecke.** (Gesell. Wiss. Göttingen, Nachr. Math.-Phys. Klasse, 1. pp. 1–16, and pp. 32–38, 1908.)—A spherical space is here considered between an internal positively charged conductor, subsequently assumed to be spherical, and an external closed conducting surface connected to earth, also subsequently assumed spherical. The volume of the enclosed space is Ω. It is assumed that in this space $q\Omega$ positive and the same number of negative ions are liberated per second. They make their way respectively towards the outer and inner conducting surface, and it is assumed that the motion is so rapid that the loss by recombination and by diffusion may be neglected. In the stationary state as many positive ions must be absorbed by the outer surface as are liberated within Ω in the same time, and a similar equation holds for the negative ions. The external force assumed to act within Ω is the electric force due to the charge on the inner conductor and to the different densities of the positive and negative ions. It is denoted by (F_x, F_y, F_z). The fundamental equations are given in the following form: The density in Ω of positive ions is $\overset{+}{N}$, of negative ions $\overset{-}{N}$. The velocity of positive ions has components $\overset{+}{g}_x, \overset{+}{g}_y, \overset{+}{g}_z$, of negative ions $\overset{-}{g}_x, \overset{-}{g}_y, \overset{-}{g}_z$. The rate at which recombination takes place (afterwards to be neglected), is per second $\alpha \overset{+}{N} \overset{-}{N}$. Then we have hydrodynamically the equations—

$$\frac{\partial \overset{+}{N}}{\partial t} = -\left(\frac{\partial \overset{+}{N}\overset{+}{g}_x}{\partial x} + \frac{\partial \overset{+}{N}\overset{+}{g}_y}{\partial y} + \frac{\partial \overset{+}{N}\overset{+}{g}_z}{\partial z}\right) + q - \alpha\overset{+}{N}\overset{-}{N}$$

$$\frac{\partial \overset{-}{N}}{\partial t} = -\left(\frac{\partial \overset{-}{N}\overset{-}{g}_x}{\partial x} + \frac{\partial \overset{-}{N}\overset{-}{g}_y}{\partial y} + \frac{\partial \overset{-}{N}\overset{-}{g}_z}{\partial z}\right) + q - \alpha\overset{+}{N}\overset{-}{N}$$

Then if $\overset{+}{k}$ and $\overset{-}{k}$ are the diffusion coefficients for positive and negative ions respectively, ν the velocity of light, U, V their absolute mobility, he finds—

$$\overset{+}{N}\overset{+}{g}_x = \nu U \overset{+}{N} F_x - \overset{+}{k}\frac{\partial \overset{+}{N}}{\partial x} \qquad \overset{-}{N}\overset{-}{g}_x = -\nu V \overset{-}{N} F_x - \overset{-}{k}\frac{\partial \overset{-}{N}}{\partial x}$$

with corresponding equations. From which—

$$\frac{\partial \overset{+}{N}}{\partial t} = -\nu U \operatorname{div.}(\overset{+}{N}F) + \overset{+}{k}\Delta\overset{+}{N} - \alpha\overset{+}{N}\overset{-}{N} \qquad \frac{\partial \overset{-}{N}}{\partial t} = \nu V \operatorname{div.}(\overset{-}{N}F) + \overset{-}{k}\Delta\overset{-}{N} - \alpha\overset{+}{N}\overset{-}{N}$$

The charge on an ion is in electrostatic measure ϵ. The components in the same measure of the electric current c_x, c_y, c_z. This leads to—

$$\operatorname{div.} F = 4\pi\epsilon(\overset{+}{N} - \overset{-}{N}) \qquad \epsilon\nu(U\overset{+}{N} + V\overset{-}{N})F_x - \epsilon\frac{\partial}{\partial x}(\overset{+}{k}\overset{+}{N} - \overset{-}{k}\overset{-}{N})C_x$$

with two corresponding equations. From these fundamental equations the theory is evolved and illustrated by a diagram, but the mathematics cannot be abstracted. The results are compared with those observed by Harms [see Abstract No. 661 (1903)]. A conclusion obtained is that, in similar spaces between concentric spheres, the densities of ions at corresponding points have equal values when the charges on the inner conductors vary as the enclosed spaces.

In the second part he considers the theory from a somewhat different standpoint. Air is assumed here to have constant velocity $-u$ in the direction taken for x, and a sphere having a negative charge e is assumed to have its centre at the origin. A positive ion situated in the plane of $x\,y$ has the constant velocity of the air, and also the velocity due to the charged sphere. Hence we have, for the motion of this ion, the equations—

$$\frac{dx}{dt} = -u - \nu \mathrm{U} e \frac{x}{r^3} \qquad \frac{dy}{dt} = -\nu \mathrm{U} e \frac{y}{r^3}$$

and—

$$y\frac{dx}{dt} = \frac{\partial}{\partial y}\left(\nu \mathrm{U} e \frac{x}{r} - \frac{1}{2} u y^2\right) \qquad y\frac{dy}{dt} = -\frac{\partial}{\partial x}\left(\nu \mathrm{U} e \frac{x}{r} - \frac{1}{2} u y^2\right)$$

If $\nu \mathrm{U} e \frac{x}{y} - \frac{1}{2} u y^2 = \psi$, we get—

$$y\left(\frac{d\psi}{dx}\frac{dx}{dt} + \frac{d\psi}{dy}\frac{dy}{dt}\right) = 0 \qquad \text{or } \nu \mathrm{U} e \frac{x}{r} - \frac{1}{2} u y^2 = \text{constant.}$$

The curves traced by the positive ion depend on the distance b which it has from the x axis at a great distance from the charged sphere, and are traced and shown by a diagram. The same is done for a negative ion. It is found that, in the stationary state, the number of positive ions which are extinguished by falling into the charged sphere is independent of u. This agrees with the results obtained for air at rest if no account be taken of the generation or diffusion of ions, which, however, become in general more important as u diminishes. The paper ends with certain numerical calculations. [See also Abstract No. 1086 (1902).] S. H. B.

1219. *Electrical Dimensions and Formulæ.* **G. Giorgi.** (Atti dell' Assoc. Elettr. Ital. 7. pp. 7–25, and pp. 57–63, Feb., 1903.)—A closely reasoned paper, advocating the surrender of K and μ, which imply specific properties of the ether, and the adoption of the standard ohm as a concrete unit; and then the use of a system of units based upon the ohm, the meter, the kilogram, and the second. On pp. 57–63 he shows how the electric formulæ are simplified, 4π being eliminated, by using instead of K a quantity κ, which is equal to (displacement/electric force) and may be defined as the capacity of the medium per unit of volume. The magnetic equations are cleared of anomalies (*e.g.*, that $\mu = 1 + 4\pi k$ has nothing to do with 4π and sums together a number and a physical quantity, as also does the equation $\mathrm{B} = \mathrm{H} + 4\pi \mathrm{J}$) by using λ the inductivity ($= 4\pi\mu$) and the magnetic force $\mathrm{F}(= \mathrm{H}/4\pi)$, instead of μ and H, leaving B unaltered, and reducing J, m, &c., by division by 4π. [See also Abstract No. 483 (1902).] A. D.

1220. *Molecular Forces and Electric Charges of Molecules.* **M. Reinganum.** (Ann. d. Physik, 10. 2. pp. 334–353, Jan. 27, 1903.)—Electrolytic phenomena serve to show that neutral molecules have positive and negative electric charges; suppose that these charges have their centres separated from one another by some, however small, distance. The paper deals with the forces called into play in ordinary matter, which consists of a group of such neutral molecules. The questions may be asked: (1) Is the distance between the two charges on a molecule constant or is it a function of outside charges? (2) Are charges on a molecule freely mobile between themselves, or are they so linked that some outside charge would exert a turning movement on the molecule? On neither of these points need any hypothesis be made in the following discussion. Consider a gas; let σ be the diameter of a molecule, and ϵ a small length. Round any molecule describe a shell with radii σ and $\sigma+\epsilon$. Let the total volume of these shells be V_σ. Let the number of molecule centres lying in the shells be n_σ; the remaining space in the gas be V_g, and the number of molecules in it be n_g. Then $n_\sigma/n_g = V_\sigma/V_g . e^{\frac{c}{T}}$. The factor $e^{\frac{c}{T}}$ is important and recurs throughout the reasoning. T is the absolute temperature, and c is a complex quantity involving the work done in the motion of a molecule and the force between two neighbouring molecules. The author deduces expression for the mean free path and the coefficient of internal friction. In the case of internal friction, tables are drawn up for air, CO_2, CH_3Cl, C_2H_4 and hydrogen, showing a very close agreement between the values observed and those calculated. The paper concludes with a reference to certain chemical properties. A paper follows the above dealing with certain simple chemical changes on the above basis. [See Abstract No. 1260 (1903).]

P. E. S.

1221. *Electric Earth-Current Disturbances and their Origin.* **J. E. Taylor.** (Roy. Soc., Proc. 71. pp. 225–227, Feb. 13, 1903.)—The author refers to disturbances noticed during experiments on wireless telegraphy for the British Postal Telegraphs. The noises are distinct from the ordinary telegraphic and inductive disturbances. They are more frequent in summer than in winter, most in evidence for a few hours about sunset, and herald the approach of a storm or gale. The noises recall flowing and bubbling water, further, crackling and rocket discharges; these latter the author ascribes to the passage of meteors which set up electric discharges in the upper rarefied atmosphere. The other noises he connects with the ionisation of the air; disturbances are caused when the ionisation is dissipated by an electric field. There are also high-frequency effects noticeable only on the coherers or other forms of Hertzian wave receivers.

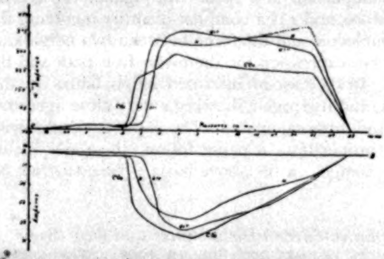
H. B.

1222. *Dispersion of Atmospheric Electricity.* **P. Czermak.** (Phys. Zeitschr. 4. p. 271, Feb. 1, 1903.)—From one year's observations, the author concludes that the dispersion has its minimum in winter and a steady high value in summer. The dispersion begins to decrease in autumn and sinks to its minimum with snowfall, probably because frost and snow prevent the ionisation through emanations from the soil (Elster and Geitel). The daily minimum lies between 11 a.m. and noon; the maximum between 4 and 5 p.m.; at higher elevations the extremes are delayed by two hours. High dispersions are observed with foehn winds (in winter) and with cumulus formation.

H. B.

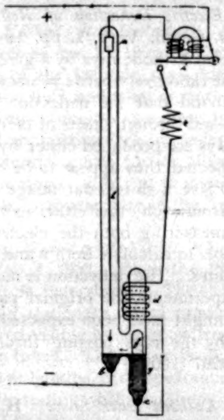
DISCHARGE AND OSCILLATIONS.

1223. *Electrical Conductivity in the Electrodeless Discharge.* **B. Davis.** (Amer. Journ. Sci. 15. pp. 202–206, March, 1903.)—The current produced in gases by the electrodeless ring discharge is very intense, but of short duration, and produces great ionisation of the gas subject to the discharge. The outer coatings of two Leyden jars are connected to a coil of wire, through a hot wire ammeter ; the inner coatings to a spark-gap and also to the ends of the secondary of a large induction coil worked by an alternating current of periodicity 40. The exhausted vessel, in which the ring discharge takes place, consists of two cylindrical glass vessels of different diameters, placed one within the other, the edges being fused together at the top. Aluminium ring electrodes extend round the top and bottom of the annular exhausted space. A constant potential difference of 220 volts was maintained at these electrodes. At this potential, no current passed between the electrodes except when a discharge was passing. This arrangement of the electrodes made the field of the e.m.f. perpendicular to that produced by the oscillations in the coil. When there was no exhausted vessel in the coil, the ammeter indicated a large current, viz., 15·8 amperes. On putting the vessel, properly exhausted, into the coil, this current became much less, in some cases dropping back to 11 amperes. This falling-off appears to be due directly to absorption of energy by the gas. The conductivity of the gas was measured by the current passing between the ring electrodes, for which purpose a delicate galvanometer is included in this circuit. The results obtained are shown in the curve, the abscissæ being decreasing pressures of the enclosed gas, and the ordinates of the upper curves the current passing between the electrodes in micro-amperes. The curves below the line A B represent the readings of the ammeter, showing the decrease of current in the coil, caused by the discharge in the vessel. [See also Abstract No. 1867 (1902).] E. C. R.



1224. *Influence of Electric Field on Spark Discharge.* **M. Cantor.** (Ann. d. Physik, 10. 1. pp. 214–216, Dec. 30, 1902.)—A continuation of the author's experiments on the spark discharge [see Abstract No. 464 (1903)]. In a previous paper it has been shown that an electrostatic field perpendicular to the direction of the discharge causes a fall in the sparking potential. The influence of an oscillating field is now studied, the oscillating potential being too small of itself to produce a discharge. In one case, the oscillatory field caused the potential at the electrodes to drop from 3,200 to 2,100 volts. Of two copper plates, one was joined to the oscillator and the other to a gold-leaf electroscope ; when the electroscope was uncharged, the varying field caused the leaves to waver. If positively charged there is, in addition, a small charging up ; if negatively charged, a rapid dissipation of the electricity. R. S. W.

1225. *The Mercury Arc.* **C. P. Steinmetz.** (Elect. World and Engineer, 41. pp. 316–317, Feb. 21, 1903.)—The mercury arc in a vacuum has usually been started by a high-voltage discharge. With such an arrangement it is not possible to use mercury arcs in series. An arc consuming 80 or 90 volts would have a length of 4 or 5 ft., but if joined in series, tubes of 12 or 18 in. can be operated efficiently. Weintraub has devised a means of starting a mercury arc without any increased voltage being necessary, and this device is described in the present article and shown in the appended diagram. The positive terminal *a* is of graphite, to this is connected a carbon filament *h* which assists in starting the arc. There are two negative mercury terminals *b* and *c*. The connections are as shown. When the circuit is closed the current passes through *i*, *e*, *d*, *c*, *b*. The solenoid *d* then lifts the iron core *f* out of the mercury cup and the mercury falls in *c*, and the circuit being broken between *b* and *c*, a small arc is found at this point which instantly flashes up to *a*, forming the main arc in tube *a b*. The magnet *i* may either be used to cut out the side branch *b c*, or cut resistance into the circuit, leaving a small arc between *b* and *c*. This last alternative increases the stability of the main arc. Mercury arcs are said to be very stable. The author states that he has used several in series for lighting his laboratory ; the current is supplied from the end of a tramway trolley line, and though the volts are apt to vary from 280 to 600, and the current from 2·5 to 8 amperes, no serious difficulties have arisen. W. H. S.



1226. *Ionisation of Water Nuclei.* **C. Barus.** (Amer. Journ. Sci. 15. pp. 105–120, Feb., 1903.)—In this paper the author describes some experiments made on the condensation and ionisation of water nuclei, following largely the method previously employed in his experiments on phosphorus emanation [see Abstracts Nos. 58, 59, and 60 (1902)], with which the present results are compared. They show that positive as well as negative charges are dissipated by water nuclei immediately after they have been produced, and that the ionisation is quite of the order of that of phosphorus. Phosphorus nuclei are small as compared with water nuclei. In none of the present experiments is there evidence that negative ions are more active as condensation nuclei than positive ions. The author considers J. J. Thomson's discovery of radio-activity, associated with water nuclei, but concludes that it is not necessary, as a result of that discovery, to abandon his own theory. The present experiments are held to confirm the views previously expressed. [See also Abstract No. 509 (1903).] W. C. H.

1227. *Ionisation of Water and of Phosphorus Nuclei.* **C. Barus.** (Amer. Journ. Sci. 15. pp. 217–223, March, 1903.)—This paper describes further experiments on the same subject as that of preceding Abstract, and the outcome is that the author is led to adhere to the essentials of his old hypothesis. W. C. H.

1228. *Magnetic and Electric Deflection of Reflected Kathode Rays.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 1. pp. 14–22, Jan. 15, 1903.)—As is well known, the deflection of kathode rays by a given magnetic field depends upon their velocity and the ratio e/m (where $e=$ electric charge and $m=$ mass). Various observers have found that the deflection of rays which have been reflected from or have passed through sheets of metal, differs from that of the direct rays. If kathode rays are produced either by a battery or an influence machine and are then deflected, they appear to be homogeneous. Reflected rays, on the other hand, give a drawn-out image on a photographic plate showing that they differ from each other either in velocity or in the ratio e/m or in both of these. By measuring both the electric as well as the magnetic deflection, the author is able to calculate both v and e/m. The method used is a modification of Kaufmann's. The deflection is measured photographically. For the theory of the experiments, the original paper must be referred to. The results show that, as might have been expected, e/m is constant, but v is altered by reflection or by the rays passing through thin metallic sheets. [See also Abstract No. 2267 (1902).] R. S. W.

1229. *Development of Kathode Dark Space.* **H. Ebert** and **P. Ewers.** (Ann. d. Physik, 10. 1. pp. 72–104, Dec. 30, 1902.)—In an earlier paper Ebert has given the law connecting the pressure of the gas and the length of the kathode dark space as $d{\cdot}p^m=$ const., p being the pressure, d the length of the space, and m a quantity less than unity [see Abstract No. 102 (1901)]. The present paper contains a large number of further measurements on oxygen, hydrogen, carbon dioxide, carbon monoxide, and nitrogen. The discharge vessel has a volume of 4 litres, so that the influence of the walls has no effect. The influence of the current is not shown in the tables published, as it is found that with currents much less than 10 milliamperes irregularities appeared. When the pressure is lower than about 1·5 mm., it is noticed that the first negative layer rapidly increases in thickness; in that case, it is not sufficiently accurate to measure the length of the dark space from the kathode to its outer boundary. The length of the space appears to depend in some degree on the shape of the kathode. For oxygen, it is found that the product pR (R being the volume of the dark space) is nearly constant, which may be interpreted physically as meaning that the space is always filled with the same mass of gas. In nitrogen, R is found to be much bigger than in oxygen under similar conditions of pressure and current, in some cases twice as great; pR increases, though slowly, with decreasing pressure. The quantities d, R, and pR, are much larger in hydrogen than in any other gas at the same pressure; not only that, but they increase much more rapidly, so much so in fact, that the m of the formula $d{\cdot}p^m$ becomes nearly equal to unity.

With some gases, it was found that the product pR had a minimum value at a pressure of 1 mm. No simple relation was found between d and the mean free path of the molecules. As for the energy consumed at the same pressure, it is found that hydrogen heads the list, and the others come in the following order: CO, CO_2, N, O. Other things being equal, more energy is consumed when the dark space is great. Curves being plotted between p and R, throughout the whole range of pressure the volume of the space in hydrogen is greatest, in oxygen least; the curves for the other gases cross each other. If pR, in ergs, is plotted against p, most of the gases show a minimum value of the energy; hydrogen is an exception, and the energy in this case is far greater than in any other gas. R. S. W.

1230. *Braun Tube for Kathode Ray Deflection.* **A. Wehnelt.** (Deutsch. Phys. Gesell., Verh. 1. pp. 29–34, Jan. 15, 1903.) — Various experimenters have found that the deflection of the kathode rays does not follow quickly the variations in the electrostatic field, and what is more serious, in some cases is not proportional to it. Improvements are here proposed by which these defects are overcome, and applications are suggested. One interesting curve is given, showing the potential curve for an alternating-current arc lamp. The sensibility of the apparatus is sufficient to give a deflection of 1 mm. for 2 volts. A fuller account is to appear later in the Annalen. R. S. W.

1231. *Stationary Electric Waves made Visible.* **J. J. Borgmann.** (Phys. Zeitschr. 4. pp. 266–267, Feb. 1, 1903. From the Physikalisches Institut der Kaiserlichen Universität at St. Petersburg.)—The electric waves are sent along a pair of parallel wires, and stationary waves produced by reflection from a bridge. These are rendered visible by the glow from the wires, obtained by enclosing them in vacuum tubes. The paper is illustrated by a photograph showing two complete wave-lengths, the appearance presented being brightness at the antinodes, alternating with darkness at the nodes. [See also Abstracts Nos. 217 and 743 (1903).] E. H. B.

1232. *Circularly or Elliptically Polarised Rays of Electric Force.* **A. Artom.** (Accad. Lincei, Atti, 12. pp. 197–203, March 15, 1903.)—Method for producing the above, based on the composition of two orthogonal electric oscillations of equal amplitude and frequency and differing in phase by ¼ period. A. D.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1233. *Dielectric Properties of Solid Glycerine.* **E. Wilson.** (Roy. Soc., Proc. 71. pp. 241–243, March, 1903.)—At high frequencies, obtained by resonance, Thwing gives 56·2 for the specific inductive capacity of glycerine at 15° C. The specific inductive capacity of pure liquid glycerine at 8° C. was found to be about 60, whether the frequency used was of the order 2 millions or 100. At a frequency of 120, the specific capacity varies from 60 to 4·6 as the temperature is varied from — 50° to — 100° platinum degrees. At — 48° C. the specific capacity at about 2 million frequency is 3·97. At — 44° C. at about 100 frequency, it is 54. If the refractive index of glycerine when frozen is taken to be 1·47 for short times, then Maxwell's law would indicate a specific capacity of 2·17. As 3·97 was observed at frequency 2 millions, it is possible that some residual charge has already come out at this frequency. When the glycerine was warmed up to a temperature of 10° C., it still remained solid, and its resistance was found to be 3½ times its resistance at 10° when in the liquid state. Its specific capacity at frequency two millions is 6·67. The specific capacity in the liquid and solid states at 10° C. varies approximately as the conductivity for long times. The residual charge comes out at times less than 0·00002 second, whether the glycerine be liquid or solid at 10° C.

At — 31° C. the specific capacity at 2 million frequency is 3·8. It is noteworthy that, for a time 0·00002 second, the conductivity falls and then rises as the temperature is varied from + 13° C. to — 59° C., when freezing from the liquid to the solid state; an analogous effect has been observed in soda-lime glass. E. C. R.

1234. *Constancy of Manganin Low-Resistance Standards in Practical Use.* **St. Lindeck.** (Zeitschr. Instrumentenk. 23. pp. 1–6, Jan., 1903. Communication from the Physikalisch-Technische Reichsanstalt.)—Thirty-one of the resistances which were standardised at the Reichsanstalt in the years 1897–98 and have since been in use by different firms have been again standardised, and the variations are given in the following table:—

Value of the Resistance in Ohms.	The Observed Alteration Amounted to				
	0·00 – 0·01	0·01 – 0·02	0·02 – 0·05	0·05 – 0·10	> 0·10 per cent.
0·01	in 5	3	2	—	1 resistances
0·001	„ 7	1	2	1	1 „
0·0001	„ 3	2	1	2	— „
Sum	15	6	5	3	2 resistances

Of the 31 examined, 26 have remained constant for all practical purposes, the alteration being under 0·05 per cent. The two resistances in the last column had undergone physical changes which were apparent to the eye. One had been in daily use for four years and had a coating of slime from the petroleum which had been used; the other had a deep brown colour, but no information was obtainable as to how this colouration was caused. J. B. H.

1235. *Magneto-friction in Vacuum Tubes.* **H. Pellat.** (Soc. Franc. Phys., Séances, 1. pp. 21–29, 1903.)—In a tube in which the electric discharge goes on under the influence of a strong magnetic field, the observed phenomena take place as if there existed, for the particles of gas, a sort of anisotropic friction, great perpendicular to the lines of the field, but nearly absent along them. This the author terms magneto-friction. Various experiments are described to illustrate this. The field necessary for the diffusion of the anodic set of rays due to magneto-friction to appear varies with the pressure. For a field of 1,740, the corresponding pressure is 20 mm. for hydrogen. As the pressure diminishes, so also does the field. The values for hydrogen and oxygen are widely different. [See also Abstract No. 1872 (1902).] J. W. P.

1236. *Measurement of Potential Difference by Means of the Telephone.* **F. Fischer.** (Zeitschr. Elektrochem. 9. pp. 18–22, Jan. 1, 1903. From the Physikalisch-Chemischen Institut der Universität, Freiburg, Dec. 7, 1902.)—

In his desire to render it possible to employ the telephone in making the whole of the electrical measurements necessary in electrochemical investigations, the author finds that Du Bois Reymond and Ostwald's compensation method (cf. Ostwald-Luther's Physikochemischen Messungen, pp. 367 sqq.) may be modified so as to give measurements of e.m.f. when the telephone is employed instead of the galvanometer or capillary electrometer. As the telephone only responds to fluctuations in current strength, it is necessary to connect it up with a "make-and-break" attachment; otherwise the arrangement is quite similar to the usual one. D. H. J.

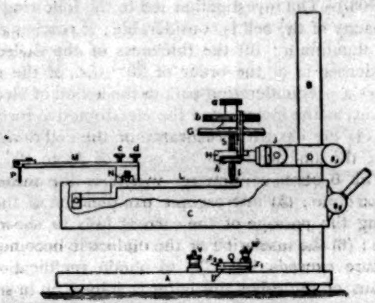
1237. *Barlow's Wheel.* **E. Carvallo.** (Journ. de Physique, 2. pp. 122–125, Feb., 1903.)—The usual instrument requires a current of at least 7 amperes and a potential difference of 0·4 volt between the axle and rim of the wheel. By suitable arrangements, and with an electromagnet in place of a permanent magnet, a wheel can be easily made to revolve thirty to sixty times a minute by the current given by an iron-constantan thermo-couple heated to cherry-redness (current 1·5 amp., e.m.f. 0·03 volt, magnetic field 3,000 gauss). The slight action between the mercury and the nickeled surfaces used causes the wheel to stop after about a quarter of an hour, but with cleaning of the nickel and renewal of the mercury, the revolution recommences. R. E. B.

1238. *Electrolytic Rectifiers.* **A. Nodon.** (Comptes Rendus, 136. pp. 445–446, Feb. 16, 1903.)—The investigation led to the following results: (1) The electrostatic capacity of the cell is considerable; it reaches a value of 1 farad per sq. cm. of aluminium; (2) the thickness of the dielectric which constitutes the condenser is of the order of 10^{-8}, *i.e.*, of the molecular order; (3) capacity plays a preponderating part in the action of electrolytic valves—such an action, *e.g.*, as the lowering of the electromotive force of the currents to be rectified; (4) the electrical resistance of the cell during the formation or destruction of the dielectric is of the order of 20 to 100 ohms-centimetre as compared with 6 ohms-centimetre, which is the mean specific resistance of the electrolyte; (5) microscopic examination of the surface of the aluminium during the passage of the current fails to show the presence of aluminium oxide; (6) the insulation of the dielectric becomes feebler as soon as the temperature exceeds 25°; (7) to obtain rectification of telephonic currents by means of the valve, the latter is joined up in series with a sensitive galvanometer and a telephonic transmitter; (8) the valves are able, in virtue of their high capacity, to transform the oscillating discharge of an air condenser into a continuous one; (9) induction effects identical with those of the interrupter may be obtained by means of an electrolytic valve. D. H. J.

1239. *Recording Galvanometer and Rotating Contact-Maker.* **J. Carpentier.** (Soc. Franç. Phys., Séances, 2. pp. 69–72, 1903.)—The galvanometer is of the Deprez-d'Arsonval type, the moving coil carrying two pointers placed horizontally. One of the pointers enables the current to be read, and the other makes a trace, by means of a recording pen, on a sheet of paper which is moved by clockwork, and the speed of which can be varied between wide limits. The rotating contact maker is an amplification of that of Joubert. A synchronous motor operates a discharge key at suitable intervals. The instrument was shown in operation, making a trace of an alternating-current wave. A. R.

1240. *Current Interrupter.* **C. F. Jenkins.** (Elect. World and Engineer, 41. p. 395, March 7, 1903.)—A rectangular cell of insulating material is provided with a transverse vertical partition in the middle of which is a conical aperature. The whole vessel is filled with dilute acid. A glass rod drawn out to a cone at one end is used as a stopper for the aperture. The aperture is drilled on the slant, so that the end of the rod which is not conical can rest upon the rim of the vessel. By withdrawing the rod more or less from the aperture, the size of the opening can be adjusted. This is claimed to be a very efficient form of interrupter. R. A.

1241. *Electric Micrometer for Laboratory Use.* **P. E. Shaw.** (Phys. Rev. 16. pp. 140–157, March, 1903.)—This paper describes a simplified form of Shaw's electric Micrometer [see Abstracts Nos. 523 and 1331 (1901)] for workshop or laboratory use. A horizontal base plate A (see Fig.) has a vertical pillar B screwed to it. On this and clamped by the screw S runs the sleeve D, which carries the measuring screw S and the nut H, there being between H and D a universal joint J. The micrometer head *a*, *b* G S H can be placed in any position. The micrometer screw S has a pitch of ½ mm., and there is a graduated disk G, having 500 divisions on it, so that each division corresponds to a movement of the micrometer screw point *t* of $\frac{1}{1000}$ mm. Each division can be subdivided by the eye into 4 parts, so that $\frac{1}{4000}$ mm. can be measured. The milled heads *a* and *b* are the coarse and fine adjustments of S. The material to be measured is placed between two steel plates having perfectly true faces, mounted on the base plate but insulated therefrom. The electric circuit is from the battery through a suitable resistance and telephone receiver to the base plate, thence to the micrometer screw. Directly this touches the top plate the electric circuit is complete and the telephone sounds. Two measurements are taken, one with the material in and one without. The difference is the desired measurement. The range of the instrument is from $\frac{1}{1000}$ mm. (μ) to 40,000 μ or more, to an accuracy of ½ μ. No appreciable pressure is necessary, as in other measuring instruments, *e.g.*, the micrometer gauge Whitworth measuring machine, and the micrometer screw S is made to work in its nuts without back-lash. The application of the method to the measurement of thin metal plates, wires, non-conducting materials, Young's modulus, torsion of a rod, thermal expansion of a tube, microscopic measurement, and the direct measurement of wave-length is described in detail. A. C. H.



1242. *Capillary Electrometer.* **P. Boley.** (Journ. de Physique, 1. pp. 784–788, Dec., 1902.)—The sensibility of the author's free-drop capillary electrometer [see Abstract No. 1105 (1902)] depends on the mobility of the meniscus and the magnifying power of the microscope used to observe displacement. The mobility of the meniscus is greatest, as the author shows, in a tube which at its effective part has the form of a hyperboloid of revolution or its practical equivalent, a cone. To make the magnification as great as possible, a kind of double microscope is recommended, in which the ocular is replaced by a real compound microscope with a wide objective. A sensitive manometer is attached to the electrometer when the latter is used for measurements of capillary constants. D. H. J.

1243. *Torsion Magnetometer free from Distant Influences.* **F. Kohlrausch** and **L. Holborn.** (Ann. d. Physik, 10. 2. pp. 287–304, Jan. 27, 1903. Communication from the Physikalisch-Technische Reichsanstalt.)—Earth currents caused by electric railways nowadays upset the working of a magnetometer. The following instrument is designed to be independent of any such exterior influences. Two cylindrical magnetic needles, 7 mm. diameter and 60 mm. long, are rigidly connected as an astatic pair 190 cm. apart; the system is suspended by a steel or iridio-platinum wire 135 cm. long and 0·06 mm. diameter. The magnet to be tested is on a horizontal level with one needle and acts on it according to the usual formula, but it acts on the other needle with components easily ascertained from their known positions. The E. and W. position of the needles is preferable, but in any azimuth the magnetometer will work well. The theory, which works out simply, is given, and the influence of temperature and other variables is considered. P. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

1244. *Theory of the Gramme Ring.* **K. R. Johnson.** (Phys. Zeitschr. 4. pp. 190–194, Dec. 15, 1902.)—When a gramme ring is rotated between the pole-pieces of a magnet, its windings are traversed by a wave of potential which travels along the wire with a velocity such that the wave remains stationary in space. The author establishes the differential equation for the current wave, and obtains its solution. He points out that the wave-length is, under ordinary conditions of working, shorter than the *natural* wave-length for the same wire, and that the wave is therefore a *forced* wave. If the conditions were such as to make the wave-length equal to the natural wave-length, there would be a rise of potential due to the removal of the constraint. A. H.

1245. *Measuring very large Alternating Currents.* **Iliovici** and **P. Janet.** (Soc. Int. Élect., Bull. 3. pp. 56–88, Feb., 1903.)—For currents less than 600 amperes, Kelvin balances can be employed. The kiloampere balance, however, as stated by the makers, reads differently with direct and alternating currents. Janet found that the balance of this type used in the Central Laboratory, Paris, reads about 4·8 per cent. lower with alternating currents than with direct. By varying the frequency and wave-shape of the current, the error could be altered by about 1 per cent. This error is due to the eddy currents in the copper bars, and the variation with frequency is due to the Kelvin effect. For large currents, transformer methods were adopted [see also A. Campbell, Phil. Mag., Sept., 1896]. Iliovici describes an experimental research to find out how the ratio of I_1 to I_2 in a transformer varies when I_2 is practically on short circuit. Interesting results are obtained, and he shows that the ratio is sufficiently nearly constant to form the basis of an accurate system of measurement, provided certain precautions are taken. He also finds a formula for this ratio in terms of the reluctance of the path of the lines of force common to the two coils and the leakage inductances of the primary and secondary coils. A. R.

1246. *Non-sinusoidal Currents.* **G. Giorgi.** (Atti dell' Assoc. Elettr. Ital. 7. pp. 34–43, Feb., 1903.)—The Fourier series representing a non-sinusoidal current may be represented by a vector diagram in space having as many dimensions as there are terms in the series. The different vectors, representing the individual terms, may be compounded into one, and thus two different non-sinusoidal variables, provided their periods are commensurate, may be treated on one plane—that common to their respective resultant vectors. Where more than two variables are to be considered it will, in general, be necessary to employ space of as many dimensions as there are variables for comparing the resultant vectors, but in many cases the relations between the variables is such that their resultant vectors lie in one plane. A. E. L.

1247. *Wiedemann Effect.* **R. Jouast.** (Écl. Électr. 34. pp. 185–191, Feb. 7, 1903.)—Wiedemann showed that if an iron wire be in a longitudinal magnetic field, and have a current traversing its length, it will undergo a twist; the twist will be in the opposite direction if current or field alone be reversed. If, keeping the current constant, the field be varied, hysteresis cycles are obtained by plotting torsion against field. The peculiarity of the Wiedemann effect cycles is that they contain two double points, the curve crossing its former path when the field has been reduced to about half its maximum. Knott pointed out that nickel presents the same general effects. The author studies several specimens of those alloys of nickel-steel (containing from 35 per cent. to 44 per cent. Ni) associated with the name of Guillaume. The hysteresis curves are of the same nature as those above mentioned, and come about midway in form between those of the component metals. P. E. S.

1248. *Effect of Temperature on Permanent Magnets.* **H. B. Loomis.** (Amer. Journ. Sci. 15. pp. 179–194, March, 1903.)—I. Experiments are made first to discover the effect of temperature on the magnetic moment of magnets of the same cross-section (0·159 cm.) but of different lengths. A magnet was suspended by a long silk fibre in a double-walled box whose temperature was either 11° C. or 99° C.; vibrations were counted, and hence M found from the well-known expression $M=\frac{4K\pi^2}{T^2H}$. Correction was made of K and of the length of the magnet for change in temperature. The proportional change in temperature $\frac{M_{11}-M_{99}}{M_{11}}$ was 0·056 for a magnet of length 21·5 cm., and increased to 0·22 as the length decreased to 5·4 cm. It was observed that $\frac{M_{11}-M_{99}}{M_{11}}$ decreases as intensity of magnetisation increases.

II. The second part of the paper deals with the effect of temperature on the distribution of magnetism in a magnet. Two magnets are dealt with at once, each in its own heating chamber; each is encircled by an exploring coil, the two coils being connected by a long brass rod, which passes outside the heating chambers so that the positions of the coils can be changed by hand. The coils are joined to a ballistic galvanometer, which is standardised regularly by an earth inductor. Then, both magnets being at 14° C., the throws are observed as the coils are moved in conjunction from end to end. The action of the two coils is of course made differential. If next one magnet is maintained at 14° C. and the other at 99° C., the movement of the coils will produce a set of throws different from the previous set if the distribution of magnetism has changed in the heated magnet. Curves for the results obtained are given in the paper and the results discussed. P. E. S.

1249. *Electrodynamic and Thermal Relations of Energy of Magnetisation.* **J. Larmor.** (Roy. Soc., Proc. 71. pp. 229–239, Feb., 1903.)—This is intended as a contribution to the theory of the magnetisation of iron, and of the extent to which its energy is electrodynamically effective. The author begins by the statement that the electrokinetic energy of any system of circuits, $i_1 \ldots i_n$, is $\frac{1}{2}\Sigma_1\int(l\alpha + m\beta + n\gamma)dS$, in which α, β, γ are components of magnetic force in a tube that threads the circuit i, and l, m, n the normal to the element dS of a surface bounded by the circuit. Then α, β, γ have a potential V, and the expression assumes the form $\frac{1}{8\pi}\Sigma\int V\left(l\frac{dV}{dx} + m\frac{dV}{dv} + n\frac{dV}{dz}\right)dS$, and this is equal to $\frac{1}{8\pi}\int(\alpha + \beta^2 + \gamma^2)d\tau$, where $d\tau$ is an element of volume. This is the expression for the electrokinetic energy of the field according to Maxwell's theory. He now substitutes molecular currents i' for magnetisation, and if there is any sensible magnetisation of the iron, these must be specially orientated—that is, not scattered at haphazard. Thus is obtained the formula—

$$\delta S.\int(\alpha dx + \beta dy + \gamma dz) = \delta S.4\pi\Sigma i + 4\pi\int(A dx + B dy + C dz)dS,$$

where A, B, C represent magnetisation. By transposition—

$$\int(\alpha - 4\pi A)dx + (\beta - 4\pi B)dy + (\gamma - 4\pi C)dz = 4\pi\Sigma i,$$

so that the vector $\alpha - 4\pi A$, &c., is derived from a potential cyclic with regard to the currents i. We find then that α, β, γ represent in the magnetised medium, not magnetic force but magnetic induction. The author now changes his notation, and writes a, b, c for α, β, γ, retaining the latter to express magnetic force. The energy is now found to consist of three parts—

$$(1)\ \frac{1}{2}\int(Aa + Bb + Cc)d\tau. \qquad (2)\ \frac{1}{2}\int(A\alpha + B\beta + C\gamma)d\tau.$$

$$(3)\ 2\pi\int(A^2 + B^2 + C^2)d\tau,$$

of which (1) is Maxwell's energy of the field; (2) is Maxwell's energy of magnetisation of the field. The question now considered is whether (3) can or cannot partially emerge as mechanical work. The author supposes a coil wound round a core of soft iron. Reference is made to Rayleigh's papers (Phil. Mag., 1885) and elsewhere. If we assume the magnetisation of the iron core to run down, it sets up by induction a current in the coil which might be made to do mechanical work. But the changes are not simultaneous. Rayleigh comes to the conclusion that a complete magnetic circuit is not advantageous in induction coils, because it diminishes the rapidity of the reversal. Another case considered is, where there are no viscous and hysteretic effects, so that the changes of magnetisation keep step with the changing currents. Does the energy of magnetisation come from the heat stored in the material, so that a cooling is produced, or is it due to the intrinsic energy of the molecules? The fact that it cannot (he says) be derived from the electric field, points to the intrinsic energy of paramagnetism being derived from purely thermal sources. And this view is supported by an illustration. Subsequently in the last paragraph he recurs to this question, and discusses a problem suggested by Rayleigh (*loc. cit.*), in which a ring coil has a flexible open core of soft iron, whose ends are bent round till they face each other. The energy of attraction between these ends as they approach each other is transformed into electrokinetic energy of the coil. Another question discussed is the loss or degradation of energy due to irreversibility in a cycle of magnetisation. S. H. B.

1250. *Temperature Coefficients of Magnets.* **B. O. Peirce.** (Amer. Acad., Proc. 38. No. 19. pp. 551–556, Feb., 1903.)—The magnets used in d'Arsonval galvanometers are generally of hardened forged steel. The author, wishing to obtain the greatest constancy in the permanent field, tests magnets of various shapes and material, and comes to the conclusion that cast-iron shows more constancy than any steel. The castings are heated to bright redness, plunged in cold acid, relaxed by prolonged exposure to steam, then magnetised to saturation, and finally seasoned by alternately treating with steam and cold water. To test the magnets he used the magnetometer method, and also, for horseshoe magnets, the ballistic method of drawing a coil from between the poles. The loss in magnetic moment per degree rise in temperature was found to be 0·00042 for seasoned cast iron, whilst for steel it varied from 0·00046 to 0·00070, according to the specimen used. P. E. S.

1251. *Magnetic Properties of Iron Powders.* **C. Maurain.** (Écl. Électr. 34. pp. 465–472, March 28, 1903.)—The iron powder is either mixed with powder of zinc or other neutral metal, or it is uniformly distributed in a rod of paraffin wax. Former researches on this subject are contradictory, partly because short magnets were used, having a large and uncertain demagnetising factor. The author uses magnets about 70 cm. long and 0·5 cm. diameter, so that this factor is negligible. Great care is taken to have a homogeneous mixture. Various iron powders were used—(1) ordinary filings, (2) reduced oxide of iron, (3) porphyrised iron. The last is best, as it contains least oxide or other impurity. For weak fields he uses the magnetometric method, and for strong fields the isthmus method. He concludes that the specific magnetisation of any given iron attains to a limiting value whatever be the density of the iron in the substance studied; but if the iron be diluted with some neutral substance, the magnetisation approaches the limit more slowly in proportion to the dilution. [See also following Abstract.] P. E. S.

1252. *Magnetisation by High-frequency Oscillations.* **F. Braun.** (Ann. d. Physik, 10. 2. pp. 326–333, Jan. 27, 1903.)—An account of various experiments, carried out in 1901, as to the effects produced by introducing finely divided iron as a core in a high-frequency oscillation transformer. The exact experimental arrangements are illustrated by five figures in the original paper, and are difficult to explain without reproduction. [See also preceding Abstract.] E. H. B.

1253. *Sun-spots and Terrestrial Magnetism.* **C. Chree.** (Roy. Soc., Proc. 71. pp. 221–224, Feb. 13, 1903. From the National Physical Laboratory.)—

Preliminary result of an analysis covering the eleven years 1890 to 1900. If S is Wolfer's value for the sun-spot frequency, and R the mean monthly range of the magnetic elements, *i.e.*, the difference between the greatest and the least of the twenty-four hourly values in the mean diurnal inequality for the month in question, based upon the five selected quiet days, then the author finds that the relation between S and R can, for inclination, declination, and horizontal force, be expressed by $R = a + bS$. The b is different from one month to the other, and larger for all the elements (except the vertical force) at the equinoxes than at the other seasons. The mean sun-spot frequencies, as deduced from the quiet days and from all the provisional figures of Wolfer, scarcely differ from one another. Linear functions, but not of the same kind, had already been proposed by Rajna and by A. Angot. H. B.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1254. *Blaze-Currents of the Incubated Hen's Egg.* **A. D. Waller.** (Roy. Soc., Proc. 71. pp. 184–193, Feb., 1903. From the Physiological Laboratory of the University of London.)—Observations on the hen's egg are described in which the author tests for the presence of the blaze reaction before and during incubation. In non-incubated and incubated, but unfertilised eggs he obtains no "blaze-currents." In fertile eggs at early stages, positive or ascending "blaze-currents" result from both directions of excitation. Later they are usually in the direction of excitation. The magnitude of the response varies with that of the exciting cause, and appears to depend on the energy rather than on the quantity of the electrical stimulus. It gradually diminished to zero as the temperature was raised from 28° to 44°. The author concludes that the presence of a blaze-current is a certain sign that development has progressed within the egg. H. W. P. Y.

1255. *Blaze-Currents of the Crystalline Lens.* **A. D. Waller** and **A. M. Waller.** (Roy. Soc., Proc. 71. pp. 194–211, Feb., 1903.)—Experiments were performed on the eyes of fish, birds, and mammals, which led the authors to the conclusion that the crystalline lens plays the principal part in the blaze reaction from the anterior half of the eyeball. The reaction in the crystalline lens persists long after it has disappeared from the remaining tissues of the eyeball and from the skin, and long after the muscles of the body have ceased to be electrically excitable. The normal direction of blaze-currents in the lens is negative. It is annulled by heat (70°) or compression. The current may be post-kathodic as well as post-anodic, antidrome as well as homodrome. H. W. P. Y.

1256. *Blaze-Currents.* **A. Durig.** (Roy. Soc., Proc. 71. pp. 212–219, Feb., 1903.)—This paper contains the results of experiments to determine whether the so-called "blaze-currents" are to be regarded as a proof of the persistence of life. When a freshly removed eyeball is employed, and the electrodes placed on the cut end of the optic nerve and on the cornea, the latter is found to be positive to the former. If the electrode is moved away from the middle of the cornea nearer to the equator of the eyeball, the currents of rest become less. After the experiment has lasted some time, this current becomes reversed. This response to light is always in the same direction as the current of rest, the positive variation being preceded by a negative jerk. When the light is extinguished, a further positive change occurs which subsequently diminishes. The extent of the excursion increases with the duration and strength of the illumination, within certain limits. After previous excitation by electric currents, excitation by light usually results in an augmentation of the excursion. Electrical effects in response to light can be obtained from the anterior part of the eyeball alone, the excursion, however, being very small. Results obtained with the eyeball in response to excitation by electrical currents are not in any way affected by the presence or absence of light. When the one leading-off electrode is moved away from the cornea towards the equator of the eyeball, not only is the difference of potential between the two poles diminished, but the effect produced by an induction shock has now almost vanished. If the posterior part of the eye alone is placed on the electrodes and stimulated, only a very slight variation occurs. From the freshly removed lens well-marked, though weak, resting currents are obtained in a constant and definite direction according to the position of the electrodes. In response to excitation, effects in a positive direction occur whatever the direction of the exciting current. The ciliary body also gives results, but the sum of the "blaze-currents" from the lens and the ciliary ring are not nearly sufficient to account for those of the whole eyeball. When the cornea is tested, however, large blaze-currents occur in response to every stimulation, and these resemble in every respect, even in their intensity, those of the whole eyeball. The resting current is from the inner to the outer surface; each induction shock, in whatever direction, produced an effect in the same direction as the resting current. According to these observations the cornea plays the principal part in the production of the "blaze-currents" of the eyeball, while that of the retina is comparatively unimportant. Electromotive effects, often very considerable, are obtained from the liver, ovary, and kidney, but these can only be regarded as due to polarisation, since they vary with the direction of the exciting current and are always opposed to it. The observer concludes that the appearance of "blaze-currents" cannot be regarded as a specific property of living tissue, but that it is more probable that they are to be considered as special manifestations of certain epithelial structures. H. W. P. Y.

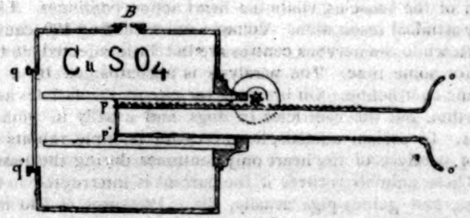
1257. *Negative Variation in the Nerves of Warm-blooded Animals.* **N. H. Alcock.** (Roy. Soc., Proc. 71. pp. 264–282, March, 1903.)—The nerves experimented with were obtained from the animals half an hour after death. They were placed in a 1·05 per cent. solution of NaCl at 30° C. for half an hour and then allowed to cool to room temperature. The negative variation of nerves so treated is found to be of the order of 1 millivolt. For its determination the method of Waller was employed, tetanising shocks from a "Berne" coil being applied, repeated once a minute. The minimal effective excitation was 6 units of the "Berne" coil; 500 units is commonly a maximum, 1,000 nearly always so. The voltage of negative variation persists 4 to 8 hours post-mortem. It varies with the kind of animal, guinea-pigs giving a high, pigeons a low value, while all warm-blooded animals give lower figures than the frog. Different nerves of the same animal give different results. Exposure to ether or to chloroform vapour greatly diminishes the effect often to zero, subsequently there is a gradual return to about the value obtained before the experiment. Treatment with carbonic acid causes great diminution, followed by a secondary augmentation. After prolonged tetanisation, the value obtained is as a rule less than before. The irritability of the nerve is permanently destroyed by raising the temperature above the normal temperature of the animal. The author thinks that this phenomenon is due to the coagulation of the proteids in the nerve, since there is a close relation between the temperature of extinction and the coagulation point of the proteids of the body of the animal. Reduction of temperature also causes abolition of negative variation. The extinction point, which is —3·5° for the frog, rises gradually from that level through hibernating animals, mammals, and birds. H. W. P. Y.

1258. *Nature of Accidents and Death due to Industrial Electrical Currents.* **F. Battelli.** (Archives d'Él. Médicale, 10. pp. 777–799, Dec., 1902.)—Experiments on animals prove that electric currents cause death in two ways, according to the voltage. When an alternating voltage of 1,200 or more is applied between the head and legs of animals, death ensues from inhibition of the respiratory centre. The blood pressure rises enormously through the tetanisation of the muscles, while the heart action continues. Life may be restored by artificial respiration. Voltages not exceeding 120, cause paralysis of the heart, while the nervous centres are but little affected, and breathing continues for some time. The paralysis is accompanied by a disordered non-rhythmic contraction. On breaking the circuit, the auricles assume their normal rhythm, but the ventricles in dogs, and usually in guinea-pigs, do not recover. In certain animals, however—for example, rabbits and rats—this form of paralysis of the heart only continues during the passage of the current. These animals recover if the current is interrupted in time, while dogs always, and guinea-pigs usually, die. Pressures of 240 to 600 volts produce in dogs both arrest of respiration and paralysis of the heart. When the heart of a dog has been paralysed by a current of low voltage, it can be made to beat again by the application to the actual wall of the organ of a current of high voltage, and in this way life may be restored. The nervous phenomena produced are chiefly arrest of respiration, tonic or clonic convulsions, and loss of consciousness. They vary with the voltage, with the point of application of the electrodes, and with the size of the animal, being most marked when the voltage is high, when the electrodes are placed close to the nervous centres, and when the animal is small. Continuous currents act in much the same way as alternating ones, but, with the former, a voltage four or five times greater is required to paralyse the heart. The effect of continuous currents on the nervous system, however, is more marked than that of the alternating and is developed more rapidly. The frequency of alternating currents is an important factor. About 150 ∿ is the most fatal. Above this the minimum voltage required to cause death increases rapidly, *e.g.*, 15 volts at 150 ∿ will kill a dog with the electrodes in the mouth and rectum ; 200 ∿ requires 35 volts, and 1,700 ∿ 400 volts. Between 30 ∿ and 150 ∿ the difference is not great. The duration of the current, other conditions being equal, naturally influences the effects produced. Autopsies on animals and human beings killed by electricity do not show any very characteristic conditions, excepting skin-burns.

The author considers that sudden death is due exclusively to paralysis of the heart of the same nature as that which he observed in animals, and he thinks that this condition persists after the current has ceased to flow through the body, as it does in the dog. If the heart is thus paralysed, no practical method of treatment can prevent the fatal issue. Industrial alternating currents of frequencies varying from 30 to 150 may be said to become dangerous at 400 to 500 volts, and continuous currents at 1,500 volts.

H. W. P. Y.

1259. *Actinometer for Use in Phototherapy.* **Bordier** and **Nogier.** (Archives d'Él. Médicale, 11. pp. 1–6, Jan., 1903.)—An instrument designed for the purpose of comparing the chemically active effect of the various sources of light used for phototherapeutic purposes. A brass box possessing an aperture at either end, has one of these (q q') closed with a disc of quartz at which the light to be tested is allowed to enter. Into the other aperture, a cylinder is cemented which projects into the interior of the box almost to the inner surface of the quartz disc. Fitting closely into this cylinder is a second tube which can be moved up and down by means of a rack and pinion. The inner end of this tube is closed by a quartz disc, one-half of the surface of which is coated with platino-cyanide of barium, the other half with a black opaque varnish. At the outer end of the tube an eyepiece (o o') is provided, shaped so as to fit closely to the face of the observer and prevent any light from entering during the observation. The box is filled with a solution of ammonia and copper sulphate of definite strength. In use, the aperture closed with the quartz disc is directed towards the source of light and the fluorescent film which is at first in close proximity with the quartz disc, is gradually moved away from it by the rack and pinion until the eye can no longer detect any fluorescence of the platino-cyanide. The thickness of the stratum of copper sulphate solution which is required to cut off all the chemical rays is a measure of the radio-active strength of the light. A Lortet-Genoud lamp, taking 20 amperes, required 58·5 mm.; a large arc with vertical carbons 55·5 mm.; while direct sunlight required a thickness of 79·5 mm. of the solution. The apparatus can be used for testing the intensity of X-ray tubes and estimating the ultra-violet radiations from a Geissler tube. H. W. P. Y.



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1260. *Mechanism of Electrochemical Phenomena.* **M. Reinganum.** (Ann. d. Physik, 10. 2. pp. 354–359, Jan. 27, 1903.) [See also Abstract No. 1220 (1903).]

1261. *Spark Micrometer.* **M. T. Edelmann.** (Phys. Zeitschr. 4. pp. 240–241, Jan. 15, 1903. Communication from the Physikalisch-Mechanisches Institut.)—Describes a convenient spark-gap arrangement made in several sizes and fitted with micrometer adjustment of the gap reading to 0·001 mm. E. H. B.

1262. *Polarised Relay.* **K. G. Frank.** (Zeitschr. Instrumentenk., Beib. 1. pp. 1–2, Jan. 1, 1903.)—This is a polarised relay of the ordinary pattern, but with fine adjustment. It is said to respond to 0·000015 of an ampere. R. A.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1263. *Metallic Hydrides.* **H. Moissan.** (Comptes Rendus, 136. pp. 591–592, March 9, 1903.)—A thick layer of perfectly white crystallised potassium hydride was condensed in a glass tube having two wires of platinum placed across it perpendicularly to its axis. The tube was sealed, when full of hydrogen, immediately after the hydride was prepared and which thus had no contact with the air. No current could be made to pass between the platinum wires. Under the microscope, the layer of hydride showed as a perfectly homogeneous and continuous mass. Hydride of calcium and lithium, prepared by the direct union of the metal with hydrogen, and which are in the form of a transparent and solid mass, are non-conductors of the electric current. These results lead to the conclusion that hydrogen is not comparable to the metals, and that hydrides cannot be likened to definite alloys, of which they have neither the appearance nor the properties. E. C. R.

1264. *Dynamic Isomerism of Thiourea and Ammonium Thiocyanate.* **J. E. Reynolds** and **E. A. Werner.** (Chem. Soc., Journ. 83. & 84. pp. 1–8, Jan., 1903.)—The transformation of ammonium thiocyanate into thiourea, on heating, is only partial, while also molten thiourea passes slowly back into the thiocyanate. Assuming that the reaction is conditioned solely by heat, these changes have been cited by Lowry as examples of "dynamic isomerism." The authors' experiments on the influence of temperature and time on these transformations lead to the following results: At 170° molten ammonium thiocyanate undergoes conversion into thiourea until, after 45 minutes, a maximum change of 24·7 per cent. is effected; longer heating results in a decomposition of a small proportion of the thiourea. At 182° the change proceeds more rapidly, but the time required to reach the maximum is approximately the same as at 170°. Thiourea is gradually transformed into the thiocyanate at 170° until, after 40 minutes' heating, only 25·8 per cent. of the original compound remains, and if the heating be continued longer no further subsequent change takes place. A state of equilibrium is hence attained, when the isomerides are present in the molten mixture in the proportion of about 25 per cent. of thiourea and 75 of the thiocyanate, and these numbers correspond with a compound of the composition, $CSN_2H_4(NH_4CNS)_3$. The authors assume that the conclusion of the change is conditioned by the formation of this compound, which appears to be more stable at high temperatures than its constituents. This assumption is confirmed, firstly, by the separation of a crystalline aggregate of the above composition from ammonium thiocyanate, which has been kept for 40 minutes at 170° and then slowly cooled; and, secondly, by the fact that with mixtures of these two compounds the minimum melting-point is shown when 25 per cent. of thiourea is present. Further, this complex is not completely decomposed into its constituents by solvents if the latter be not used in large excess; thus by treating the complex with small proportions of acetone, crystals of the compositions CSN_2H_4,NH_4, CNS and $(CSN_2H_4)_3$, NH_4CNS, may be obtained. T. H. P.

1265. *Effect of Superheated Steam upon the Tensile Strength of Alloys.* **J. L. Hall.** (Metallographist, 6. pp. 3–8, Jan., 1903.)—A bronze which initially had tensile strength 80,480 lbs. per sq. in., elongation 22 per cent., had tensile strength 76,090 and elongation 26·5 per cent. after heating to 320°; tensile strength 76,000 and elongation 29 per cent. after heating 25 times to 320°; tensile strength 75,280 and elongation 30·0 per cent. after heating once to 440°. The effect of this treatment is thus only slight, but tests made at 320° gave a reduction of 60·4 and 68·8 per cent. in ultimate tensile strength. Microphotographs are given, showing the influence of thermal treatment on the structure of the alloy. T. M. L.

1266. *Alloys of the Gold-silver Series.* **W. C. Roberts-Austen** and **T. Kirke Rose.** (Roy. Soc., Proc. 71. pp. 161–168, Jan., 1903.)—It had been shown in previous communications [see Abstract No. 166 (1901)] that the gold-copper alloy used for coinage was not homogeneous after solidification, and therefore was unsuitable as a material for the preparation of the trial plates by which the standard of the coinage is tested. Uniformity after cooling can be shown by isomorphous mixtures only, and Gautier in 1896 proved that gold-silver alloys obeyed this condition. The present paper gives determinations and photographs of structure confirming this conclusion. Such an alloy has been used in the Royal Mint since the beginning of the present year, instead of fine gold, for checking assays of standard bars and coins, and by this method any errors are avoided which might be caused by accidental variations in weight occurring after the trial plates had been made. S. R.

1267. *Simultaneous Presence of Ferrite and Cementite in Steel.* **E. F. Lange.** (Metallographist, 6. pp. 9–13, Jan., 1903.)—Sauveur in 1896 stated that free ferrite and free cementite never exist together in the same steel, but separate as the eutectic alloy pearlite, only the excess appearing as free ferrite or free cementite. Under certain conditions, however, the pearlite may be entirely segregated into its constituents, and an alloy is described having combined carbon 0·38, Si 0·25, Un 0·70, S 0·03, P 0·05, which gave an exceptionally good test, but consisted entirely of free ferrite and cementite and contained no pearlite; in other specimens the segregation was only partial. Similar observations have been made by Stead and by Arnold, and **A. Sauveur,** in a postscript to the paper, accepts the statement now put forward. The segregation appears to be brought about by prolonged heating between 600° and 700°. T. M. L.

1268. *Experimental Researches on Drawn Steel.* **J. R. Ashworth.** (Roy. Soc., Phil. Trans. 201. pp. 1–35, March 11, 1903. Roy. Soc., Proc. 70. pp. 27–30, May 12, 1902.)—This paper is divided into two parts. The first gives a complete investigation of the temperature coefficient of a magnet. The experiments were mostly made on twelve samples of pianoforte steel wire, representing every stage in the process of drawing from the rolled rod, through annealing and tempering, to the fine-drawn wire. In part two, the twelve samples were examined for resistivity and its temperature coefficient; for Young's modulus and its temperature coefficient, and for density. For the results obtained reference must be made to the original paper.

E. C. R.

1269. *Action on Metals of Solutions of Hydrochloric Acid in Various Solvents.* **H. E. Patten.** (Journ. Phys. Chem. 7. pp. 153–189, March, 1903. Paper read at the Washington Meeting of the American Chemical Society, Dec. 30, 1902.)—A carefully dried solution of hydrogen chloride in chloroform has no visible action on Fe, Ni, Cu, Ag, Au, Pt, As, Te or Pd, but acts on Zn, Al, Mg, Sn, and Pb, the action being greatest in the case of zinc, and least in the case of lead; the conductivity of the acid solution was exceedingly small. A solution in carbon tetrachloride acted vigorously on zinc and less vigorously on aluminium, whilst magnesium was not acted on during two hours; lead, tin, iron, and cadmium were slightly attacked, but no action occurred in the case of Ni, Cu, Ag, Sb, Bi, Mn, Cr, As, Te, Pt, Pd or Au, and contact of one metal with another made no difference in any of the interactions. A solution in ethyl chloride rapidly acts on zinc; lead and tin become corroded without liberating gas, and magnesium is corroded very slowly, aluminium steadily liberating gas after the first ten minutes. A solution in benzene acted vigorously on zinc, but not on magnesium or aluminium, even when a trace of moisture was admitted from the air. Other solvents used were $SnCl_4$, $SiCl_4$, PCl_3, $AsCl_3$, $SbCl_5$, S_2Cl_2, and $SOCl_2$, and the conclusion drawn is that chemical action does not depend on (1) the presence of moisture, or (2) the electrical conductivity of the solution, but is mainly determined by the individual chemical affinity of the interacting materials. The presence of moisture appears to check the interaction of zinc with a solution of hydrogen chloride in benzene by forming a less permeable coating on the surface of the zinc. T. M. L.

1270. *Cast Silica and Boric Anhydride.* **A. Dufour.** (Soc. Franc. Phys., Séances, 2. pp. 59–68, 1908.)—For work in spectroscopy these substances provide, in virtue of their well-defined chemical constitution, very convenient Geissler tubes. The methods of construction, special heating flames, and devices for tubes and bulbs are described. An example of the results on silica is the bulb for a gas thermometer 5 cm. diameter 22 cm. long, prolonged at one end by a 30 cm. long capillary. An account of the physical properties of cast silica is given. The coefficient of expansion is 5×10^{-7} between 0° and 1000. At 1200° a minimum density point is reached, above which temperature contraction occurs. The optical and electrical properties are also considered. For boric anhydride the methods of treatment are similar to those used industrially for glass. J. W. P.

1271. *Solidification of Fluorine. Combination of Solid Fluorine and Liquid Hydrogen at Low Temperatures.* **H. Moissan** and **J. Dewar.** (Comptes Rendus, 136. pp. 641–643, March 16, 1903.)—In liquid oxygen a tube containing fluorine shows no signs of condensation occurring, but when placed in liquid hydrogen a yellow liquid soon appears in the tube, and afterwards this sets to a solid; if the tube is kept in the hydrogen until it assumes the temperature of the latter, namely, —252·5°, the solid fluorine becomes absolutely white. On solidifying oxygen and fluorine in liquid hydrogen and then removing the containing tubes into the air, it is found that the oxygen melts first, and the temperature at which the fluorine melts is estimated to be —223°. The ratio of melting-point to boiling-point is rather less for fluorine than for chlorine or bromine. On immersing a thin glass tube, in which 40 c.c. of gaseous fluorine had been solidified, in 100 c.c. of liquid hydrogen, waiting a short time until the fluorine assumed the temperature of the hydrogen and then breaking the fluorine tube, an explosion occurred sufficiently violent to powder the double-walled glass vessel containing the hydrogen, which latter was inflamed by the intense heat of the reaction. T. H. P.

1272. *Formation of Sulphur Trioxide by the Contact Action of Ferric Oxide.* **G. Lunge** and **G. P. Pollitt.** (Soc. Chem. Ind., Journ. 22. pp. 79–83, Jan. 31, 1903.)—The authors' experiments give the following results: The degree of change of $SO_2 + O$ to SO_3 is not sensibly affected by changes in dilution from 2 to 12 per cent. of SO_2 by volume. The mixture of gases must be as dry as can be obtained by means of sulphuric acid, otherwise the contact action is lessened, and the contact mass requires to be treated for a long time with the dry mixture before it recovers from the "poisoning" action of the moisture. For the same reason the dry ferric oxide must not be exposed to the air. Loosening the surface of the oxide of iron does not improve the contact action; the influence of the physical formation of the oxide on the catalysis is doubtless great, but has not yet been cleared up. Addition of copper oxide to the ferric oxide favours the formation of SO_3, and an oxide containing 2¾ per cent. of arsenic, in the form of arsenious oxide, exhibits a contact action 60 per cent. greater than that of pure oxide. The best temperature for the catalytic action of the ferric oxide lies between 600° and 620°. Below 600° the action is very small, and above 620° it falls very rapidly to a certain point and remains constant up to 750°, when it again begins to fall. The fall on raising the temperature must be attributed to the fact that the system $SO_2 + O \rightleftarrows SO_3$ tends to alter its condition of equilibrium in the direction from right to left when the temperature rises. The fact that there is no appreciable change between 635° and 750° can perhaps be best explained by assuming that two kinds of intermediate reactions come into play, viz., first, the formation and decomposition of ferrisulphate, and secondly, the alternating reduction of Fe_2O_3 and oxidation of the Fe_3O_4 so formed, and that these reactions have different temperature optima. T. H. P.

1273. *Catalytic Decomposition of Ethyl Alcohol by Finely Divided Metals; Regular Formation of Aldehyde.* **P. Sabatier** and **J. B. Senderens.** (Comptes Rendus, 136. pp. 738–741, March 23, 1903.)—On passing ethyl alcohol vapours over reduced copper heated to 200°, a reaction begins and at 250° becomes more vigorous, the alcohol being decomposed solely into aldehyde and hydrogen. The same change occurs at temperatures up to 300° at which as much as half the alcohol vapour passing is decomposed. At 420°, however, the gas obtained contains equal volumes of methane (12·5 per cent) and carbon monoxide (12·5 per cent.), the remaining 75 per cent. being hydrogen; the first two of these gases are due to the breaking down of the aldehydes in presence of the copper, which begins at 400°. Using reduced nickel in place of copper, the decomposition commences at 150° and increases rapidly in vigour with rise of temperature, the volumes of gas per minute obtained in one experiment being: 8 c.c. at 178°, 24 c.c. at 210°, 95 c.c. at 250°, and 74 c.c. at 325°. A certain amount of aldehyde is obtained at 178°, but nearly half of it is destroyed, the percentage composition by volume of the gas evolved being: carbon monoxide 23, methane 29, and hydrogen 48. The excess of methane over carbon monoxide is due to the conversion of some of the latter into the former by the action of hydrogen in presence of nickel. This decomposition of carbon monoxide, as well as its resolution into carbon dioxide and carbon, which begins at about 230°, become more rapid at higher temperatures, so that at 330° the gas given off contains 19·5 per cent. of carbon dioxide, 60·7 of methane, and 19·8 of hydrogen, no aldehyde being then obtained. Cobalt acts in a manner similar to that of nickel. With spongy platinum, decomposition of the alcohol commences at 270° and proceeds with greatly increased vigour as the temperature rises. T. H. P.

1274. *Polymerisation of Organic Liquids.* **G. G. Longinescu.** (Annales Scientifiques de l'Univ. de Jassy, 2. pp. 126–130, March, 1903.)—For a large number of organic liquids of varied types, the author finds that $T/D\sqrt{n}$ has a constant value, T representing the absolute boiling-point, D the density at 0°, and *n* the number of atoms in the molecule of the liquid. The value of the expression is just about 100, and from the equation $T/100D = \sqrt{n}$, it is possible to calculate the degree of aggregation in polymerised molecules. [See Abstract No. 1958 (1901).] Tables are given showing the actual number of atoms present in the molecule and the number calculated by the formula. For the polymerised molecules, the degree of association calculated in this way agrees, in a large number of cases, with that obtained by Ramsay's capillarity method. Thus, for methyl, ethyl, and propyl alcohols, acetone and nitro-ethane, the numbers obtained are 3·1, 2·2, 1·7, 1·6, and 1·4 respectively, those of Ramsay being 3·4, 2·7, 2·2, 1·3, and 1·5. The molecule of liquid methyl cyanide has the formula $(CH_3 . CN)_3$. T. H. P.

1275. *Polymerisation of Organic Compounds in the Solid State.* **G. G. Longinescu.** (Annales Scientifiques de l'Univ. de Jassy, 2. pp. 179–183, March, 1903.)—Just as with liquids [see preceding Abstract], it is found also that for solid organic solvents, the expression $T/D\sqrt{n}$ may be regarded as having a constant value. For most of the compounds considered this value is 70, but for some others it is 50. It is therefore uncertain whether the first class of bodies possess single molecules in the solid state and those of the second double molecules, as would be the case if the number 70 be taken; or whether the first type contains double and the second quadruple molecules. There is also a third class of bodies which, with the constant 50, have normal molecules in the solid state, whilst, taking the value 70, they only have half the calculated number of atoms in the molecule. T. H. P.

1276. *Rate of Oxidation of Ferrous Salts by Chromic Acid.* **C. C. Benson.** (Journ. Phys. Chem. 7. pp. 1–14, Jan., 1903.)—The author has made an experimental study of the oxidation of ferrous sulphate by chromic acid in the absence of iodides as a preliminary to a similar study in presence of iodide. It was found difficult to devise a method of estimating ferrous salt in solutions of potassium bichromate, sulphuric acid, and ferric salts, but, eventually, the quantity of ferrous salt present was determined by measuring the increase due to it, in the rate of oxidation of potassium iodide by chromic acid. It appears from the data, that the rate of oxidation of ferrous sulphate in solutions containing both sulphuric acid and bichromate is proportional to the second power of the concentration of both ferrous salt and acid, and apparently is proportional to the 1·7th or 1·8th power of the concentration of the bichromate; this result in the case of the bichromate is, however, uncertain. The rate is much diminished by ferric salts. D. H. J.

1277. *Rate of Oxidation of Hydrogen Iodide.* **J. M. Bell.** (Journ. Phys. Chem. 7. pp. 61–83, Feb., 1903.)—In studying the oxidation of hydrogen iodide by hydrogen peroxide, Harcourt and Esson added to the mixture a little starch and successive portions of sodium thiosulphate. The iodine liberated from the HI is thereby at once removed by the thiosulphate until all the latter has been converted into tetrathionate; the blue colour of starch iodide then appears. The velocity of oxidation was measured by noting the time which elapsed after each addition of a known amount of thiosulphate till the blue colour appeared. The author points out that this method of procedure involves certain assumptions, each of which must be tested before the method is employed. Thus, *e.g.*, the thiosulphate may be acted upon by the acid present yielding sulphite; or it may be oxidised by the oxidising agent present; further, the rate of oxidation of the HI may be affected by the presence of the thiosulphate, &c. The author has investigated a number of oxidation reactions with a view to testing whether the compensation method described above can be employed. As a result, he finds that it is applicable when hydrogen peroxide is the oxidising agent; inapplicable, however, in the case of chloric acid, bromic acid, and chromic acid, the thiosulphate in these cases being itself oxidised, and the rate of oxidation being retarded by potassium iodide. Some measurements were also made on the rate of oxidation of sodium thiosulphate by chloric and chromic acids, with reference to the effect produced by adding catalytic agents and by changing the concentrations of the thiosulphate, the acid and oxidising agent. The results do not suggest any simple "mechanism" for the reaction. A. F.

1278. *Induced Oxidations.* **A. Job.** (Comptes Rendus, 136. pp. 45–47, Jan. 5, 1903.)—The induction of oxidation by cerium potassium carbonate has already been shown by the author. Other salts of cerium may be used; thus acetate of cerium, which is quite stable in the air, rapidly promotes the oxidation of solutions of hydroquinone, and does so to a greater extent than manganese acetate. Lanthanum acetate is as effective as cerium acetate, as the action of the latter depends on the existence of a peroxide of cerium; the author hence infers that a definite peroxide of lanthanum will in the future be shown to exist. [See also Abstract No. 2126 (1902).] D. H. J.

1279. *Saturated Gypsum Solutions as Bases for Conductivity Measurements.* **G. A. Hulett.** (Zeitschr. Phys. Chem. 42. pp. 577–583, Feb., 1903.)—It has been previously shown by the author [see Abstract No. 1963 (1901)] that the concentration of a saturated gypsum solution varies by as much as 20 per cent. with a variation in the size of the solid particles in contact with the solution. To be quite sure that a gypsum solution, used as a standard electrolytic resistance, is normally saturated, it is best to take clear crystals of gypsum free from chlorine and split them into laminæ, which should then be shaken with pure water for several hours. Solutions prepared in this way at different temperatures have the following conductivities:—

Temperature.	Specific Conductivity (λ).
10°	0·001486
14·8	0·001728
18	0·001879
21·48	0·002151
25	0·002208
27·5	0·002328
30	0·002445

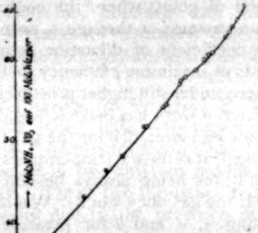
These values agree very closely with those given by the expression: $\lambda_t = 0{\cdot}002208 + \beta(t-25) + \gamma(t-25)^2$, where $\beta = 0{\cdot}0000456$ and $\gamma = 0{\cdot}0000001626$. At 18° the molecular conductivity, μ_∞, for calcium sulphate has a value of about 240. At 25° the relation connecting the specific conductivities of calcium sulphate solutions with their concentrations (in milligram-mols. per litre) is expressed by: $c = -0{\cdot}354 + 5211\lambda + 841400\lambda^2$.

The author points out that, in Arrhenius' form of resistance cell, the electrodes should always be placed in the same position relative to one another and to the vessel. It is hence advantageous to make the lower part of the cell conical, so that the lower electrode may rest on the walls. T. H. P.

1280. *Rate of Reaction in Solutions containing Potassium Iodide and Chlorate, and Hydrochloric Acid.* **W. C. Bray.** (Journ. Phys. Chem. 7. pp. 92–117, Feb., 1903.)—In this present paper, the author gives the results of a very thorough examination of the effect produced by change of concentration of each of the reacting substances on the rate of oxidation. The presence of ferrous sulphate, in small amount, greatly accelerates the oxidation of HI by chlorate and hydrochloric acid—a fact which greatly facilitated the analyses. The author also found that the rate at which iodine is liberated in solutions containing potassium chlorate, potassium iodide, and hydrochloric acid, is proportional to the concentration of the chlorate and to the square of the concentration of the hydrogen ion (between $C = 5$ and $C = 20$); and is a linear function of the concentration of the chloride ion and of that of potassium iodide. The temperature coefficient of the reaction is such, that a rise of 8·6° causes a doubling of the velocity. A. F.

1281. *Conditions of Formation of Orthoclase and Albite.* **E. Baur.** (Zeitschr. Phys. Chem. 42. pp. 567–576, Feb., 1903.)—By heating varying proportions of amorphous silicic acid and potassium or sodium aluminate with water at 520° in steel tubes for several hours and examining the crystalline solid separating out, the author finds that orthoclase and albite are only formed from solutions containing excess of the base. T. H. P.

1282. *Solubility of Ammonium Nitrate in Water between 12° and 40°.* **W. Müller** and **P. Kaufmann.** (Zeitschr. Phys. Chem. 42. pp. 497–500, Jan., 1903.)—The accompanying curve shows that there is a break at 32° corresponding to the transition temperature of the two orthorhombic modifications, which, in the absence of a solvent, was found to lie at 32·2°. T. M. L.



1283. *Equilibrium between Copper, Silicon, and Manganese. Manganese Silicide.* **P. Lebeau.** (Comptes Rendus, 136. pp. 231–233, Jan. 26, 1903.)—Silicon-copper, containing little silicon, may be considered as a liquid in which increasing quantities of silicon (in the form either of $SiCu_2$ or of free silicon) may be made to react with a given quantity of a metal. In this way there can be produced a series of chemical systems in which one or more silicides of the reacting metal may exist in addition to possible compounds of this metal with copper. The author describes investigations made after this manner on the silicon compounds of manganese, a mixture of copper, trimanganese tetroxide, potassium silicofluoride and sodium being melted, and the amounts of silicofluoride and sodium gradually increased without altering the ratio of copper to manganese. It is found that, if the molten mass contains less than 10 per cent. of silicon, the residual crystalline mass, after treatment with nitric acid, has approximately the composition $SiMn_2$, whilst if more than 15 per cent. of silicon is present, the crystals have the formula SiMn. Octahedral crystals of $MnSi_2$ have also been prepared. [See also Abstract No. 528 (1908).] T. H. P.

1284. *Corresponding Points.* **D. Berthelot.** (Soc. Franç. Phys., Séances, 1. pp. 36–52, 1908.)—Through specific units (*e.g.*, gramme-molecules, van der Waals' units based upon critical temperature, pressure, and volume), we find correspondences between the different kinds and states of matter. These correspondences have been held as establishing the hypothesis of van der Waals, for example; but the outlook is more far-reaching. The critical point of van der Waals can supply us with specific units, but it is one singular point only, out of several which have a real physical existence. In the expansion of gases into a vacuum or through a porous septum, we have thermic effect Δu, due to variations in the internal energy, and thermic effect $\Delta(pv)$ due to exterior work done. Assuming van der Waals' law to be obeyed by gases, we have four conditions which we may study; $\Delta(pv)$ a maximum, $\Delta(pv)=0$, $[\Delta(pv)+\Delta U]$ a maximum, and the same $=0$. Then on a diagram (abscissæ p, ordinates pv and isothermal lines) these respectively bring us to four parabolas, easily calculated if we know the characteristic curve, but also capable of being worked out in detail or of being traced from thermodynamical considerations, under which the first is the locus of points where the gas obeys Boyle's law; the second of points where the cooling is the same, whether the expansion be into a vacuum or through a porous septum; the third of points where the true coefficient of dilatation is inversely as the absolute temperature, or of points of maximum efficiency in the Linde machine; and the fourth of points where, under still higher pressures, the total cooling is null, for the cooling due to exterior work has become negative. Beyond this fourth parabola, even at very low pressures, driving the gas through a porous septum will heat it, and hydrogen at ordinary temperatures is always heated by this treatment, such temperatures being always beyond 6·75 × the critical temperature of that gas. If the gas obey van der Waals' law, the four parabolas have respectively (putting π, v, and θ for pressure, volume, and temperature, taken as multiples of the critical p, v, and τ° Abs.) the equations $6\pi=9(\pi v)-(\pi v)^2$, $3\pi=9(\pi v)-(\pi v)^2$, $9\pi=18(\pi v)-(\pi v)^2$, and $3\pi=18(\pi v)-(\pi v)^2$. The first and the second cut the axis of ordinates at the same point; the third cuts the second at the apex of the latter. The apices of all the parabolas present points as well defined as the critical point; and at the apex of the second, in particular, the internal pressure of the gas is equal to the external, the real volume is equal to the ideal, and this volume is twice the co-volume (b in van der Waals' formula) or minimum volume. For CO_2 this point is (from Amagat's data) at 80°, 606 atmospheres, and $pv=1{\cdot}29\times$ the pv at 0° and 1 atmosphere. The variations of internal and total energy, on passing from perfect gaseous condition to this point along the isothermal of this point, are equal to one another. On taking the coordinates of this point as units, van der Waals' equation takes the form $(p+v^{-2})(v-\frac{1}{2})=\theta$

a simple form which is of great value in problems of energy and the evaluation of molecular forces. The apex of the fourth parabola stands at absolute zero, a volume equal to the co-volume, and a pressure 27 times the critical. van der Waals' law implies, since the internal pressure is of the form a/v^2, that the work done against molecular attraction upon expansion is always positive, but Amagat's data confirm Maxwell, that at sufficiently high temperatures or pressures there may be molecular repulsions. This would lead to two new loci, ΔU a maximum and $\Delta U = 0$. These would be hyperbolas, having for asymptotes the axis $p = 0$ and the straight line $v = b$. Of these, the former (curve 5) gives points where the cooling due to internal work is a maximum, the latter gives points where it is *nil*. The apices of these curves would give other specific units of measurement, realisable, however, only at extremely high pressures. A. D.

1285. *Basis of the Theory of Solution.* **M. Cantor.** (Ann. d. Physik, 10. 1. pp. 205–213, Dec. 30, 1902.)—The theory of solutions, which Planck has deduced from considerations of entropy, is criticised, and a mathematical theory developed in which the existence of hydrates is taken into consideration. T. M. L.

1286. *Combination of Carbon Dioxide and Potassium Hydride.* **H. Moissan.** (Comptes Rendus, 136. pp. 723–727, March 23, 1903.)—The author finds that the combination of carbon dioxide with potassium hydride, yielding potassium formate, does not take place unless a minute trace of water is present. The nature of the glass of the containing tube appears to be without influence upon the interaction, which hence differs from that taking place between hydrogen and oxygen, which refuse to combine only when in Jena glass tubes. The quantity of water corresponding with its vapour pressure at − 85°, *i.e.*, less than 0·25 m.grm., is sufficient to induce the reaction. Similar results are obtained with the hydrides of sodium, rubidium, and cæsium. Traces of hydrogen chloride or ammonia have not the same influence on the combination as traces of water exert. T. H. P.

1287. *New Isomerism of Asymmetric Nitrogen.* **E. Wedekind.** (Comptes Rendus, 134. pp. 1356–1359, June 9, 1902.)—By varying the method of preparation of ethyl ethylenebis- | -tetrahydro*iso*quinoline- | -acetate di-iodide, this compound may be obtained in two different modifications, one of which is stable and the other labile. These two forms are regarded as stereo isomerides, their existence being due to the presence in the molecule of two asymmetric nitrogen atoms. T. H. P.

1288. *Relationship between Freezing-point, Boiling-point, and Solubility.* **M. Wildermann.** (Zeitschr. Phys. Chem. 42. pp. 481–496, Jan., 1903.)—In the case of non-electrolytes, the whole solubility-curve can be calculated from the eutectic-temperature and the heat of dissolution; for electrolytes, the value of the *i*-factor must also be known. Calculations are given for boric acid and potassium chlorate, which agree tolerably with the observed solubilities, but differ widely at 100°. A similar calculation can be based on the boiling-point of the saturated solution and the heat of dissolution, and here again there is a tolerable agreement below 80°. Finally, an equation is given which expresses the relationship between (1) the heat of dissolution, (2) the boiling-point and freezing-point of the solvent and of the saturated solution, and

(3) the latent heat of evaporation and of fusion; when the observed values are substituted in the case of boric acid, the two sides of the equation differ by only 2 per cent. [See also Abstract No. 371 (1903).] T. M. L.

1289. *Critical Region of Solution and Phenomena of Opalescence.* **D. Konowalow.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. No. 8a. pp. 738–766, 1902. Also Ann. d. Physik, 10. 2. pp, 360–392, Jan. 27, 1903.) —In this paper the author investigates the connection between opalescence and variations in the partial vapour-pressures, these variations being the most important criterion of solutions. It was to be anticipated that a similar characteristic property of liquid solutions in the *critical* region would be accompanied by singular alterations in the partial pressure of the vapours of both liquids constituting this solution. For this, two liquids were required, not perfectly soluble, having a sufficiently low critical temperature to allow of both the partial pressures and solubility being accurately measured. Solutions of aniline and amylene (trimethylethylene) were found suitable, the maximum temperature of separation of such a solution into two layers, viz., the *critical temperature*, being + 14·5° C. At this temperature, the partial pressure of aniline vapour is very low, so that the total pressure above the solution may, within the limits of experimental error, be assumed to be equal to the partial pressure of the amylene vapour. Observations were made on solutions of the above two liquids, though other pairs with analogous differences in volatility were investigated at the same time. The measurements of the vapour pressures were thus considerably simplified and made by a dynamical method, based on the determination of the weight of the vapour carried away by a given volume of air, the liquid itself being placed in a bulb apparatus. This was determined by means of the loss in weight of the latter, the apparatus being immersed into a mercury bath.

In order to ascertain the relation between the composition of the solution and the vapour pressure in the critical region, the limit of homogeneity had to be carefully established within the above range. Theoretical considerations, made with a view to ascertaining which was to be considered as the true bounding surface of homogeneity, led to the following results: The volume of the layer separated from the saturated solution at a given variation in temperature is the greater, the smaller the difference in the composition of both layers, and the greater the alteration in the composition of the original solution. The existence of turbidity in solutions of liquids may be observed with an accuracy increasing, as the curve representing the dependence of the composition of the saturated solution on the temperature is flatter, and the distance between two points of the same curve on the horizontal line decreases. As the limits of homogeneity are best defined in the critical region, the opalescence observed in the neighbourhood of the latter should be regarded as an independent phenomenon, to be distinguished from the separation of the solution occurring in accordance with the laws of mutual solubility.

From measurements of the partial pressures within the critical range, it is inferred that solutions within these limits closely approach *mixtures*, the tension of the vapour being, within the possible experimental error, as constant in the case of a single phase as in that of two phases. The results obtained for solutions in the critical region show a close connection between these and colloidal solutions, the dependence of the vapour pressure on the composition of a solution in the critical range evidencing an intimate analogy. Diffusion within the critical range is likely to occur extremely slowly, these solutions having to be considered as being in indifferent equilibrium as regards alterations in concentration. Such an alteration requires hardly any expenditure of energy, the slightest cause being sufficient to give rise to local disturbances of the homogeneity, in both colloidal and critical solutions.

Distinct opalescence is exhibited by such solutions as show hardly any variation in their vapour pressure with varying concentrations—solutions where the slightest expenditure of energy suffices to produce great alterations in the concentration. The opalescence visible to the naked eye, characteristic of the critical region of solution, is shown not to be a phenomenon of this region alone, but to represent only an extraordinary strengthening of the opalescence observed even in the case of pure liquids. The author thinks opalescence in liquids to be due to dust, the nearly independent behaviour of the vapour pressure of the solution in the critical range being the cause of the strengthening of the critical range. Opalescence is thus no evidence of non-homogeneity in solutions.

When comparing the curves representative of the tension of hydrogen in terms of the composition of hydrogen palladium with the vapour-tension curves of amylene in its solutions with aniline, great similarities are observed. As with the critical range of solutions, there is also in this case, at low temperatures, a curve comprising two ascending branches, a nearly horizontal intermediary portion, with an ever-increasing inclination as the temperature rises. The author therefore suggests considering hydrogen palladium as a solid solution, it being near the temperature of decomposition into two solid phases. A. G.

1290. *Theory of Electrolytic Dissociation.* **W. C. D. Whetham.** (Phil. Mag. 5. pp. 279–290, Feb., 1903.)—The bearing of recent observations of non-aqueous solutions on the theory of electrolytic dissociation is discussed, together with the difference sometimes observed between the osmotic and electrical methods of measuring the coefficient of ionisation. In support of the freedom of the ions from one another, three arguments are quoted: (1) the validity of Ohm's law for solutions, showing that no work is done by the current in causing reversible electrolytic separations; (2) the fact that the conductivity is not quite proportional to the first power of the concentration, whereas, if it depended on the formation of chains or aggregates of conducting molecules, it should be proportional to the cube of the concentration; (3) the possibility of resolving the conductivity into the sum of a pair of ionic mobilities which are independent of the associated ion. It is pointed out, however, that measurements of the coefficient of ionisation by different methods are only comparable when made in "dilute solutions"; at excessive dilutions the agreement is complete, but the gas laws of osmotic pressure would probably cease to hold good much sooner in the case of electrolytes than non-electrolytes. T. M. L.

1291. *Rapid Determination of Purity of Ammonium Chloride for Batteries.* **G. Rosset.** (Centralblatt Accumulatoren, 4. pp. 25–26, Feb. 1, 1903.)—The saturated solution should have a density at 15° C. not exceeding 1·0766, and, if pure, the addition of 25 gm. to 250 gm. of water should lower the temperature by 6°. The salt should be colourless, completely soluble and volatile, and give no precipitate with barium chloride. T. M. L.

1292. *Potentials of Amalgams.* **M. Reuter.** (Zeitschr. Elektrochem. 8. pp. 801–808, Oct. 16, 1902. From the Chem.-technischen Inst. der Technischen

Hochschule in Karlsruhe.)—The potentials of potassium amalgams at −80° C. in methyl alcohol solutions of lithium chloride were measured, in continuance of the work of Haber [see Abstract No. 176 (1903)]. The potential gradually rises with increase in concentration of the potassium until a concentration of 1 atom potassium to 12 atoms mercury is reached, when there is a sudden increase. As long as solid mercury is present together with the compound KHg_{12}, the solid amalgam shows approximately the potential of the mercury. A sudden increase (from 2,712 volts to 3,035 volts against hydrogen electrode = 0) also takes place when the composition of the amalgam changes from 98·9 per cent. atoms potassium to pure potassium. Pure sodium has the potential 2,688; this is lowered to 2,282 volts by the addition of 8·8 per cent. atoms mercury. The alteration in the potential from the amalgam KHg_{12} to the amalgams of higher concentrations corresponds with the heat of formation of the amalgams. A method is described for the preparations of pure amalgams of any required composition. T. S. P.

1293. *Cadmium Amalgams.* **W. Jaeger.** (Zeitschr. Phys. Chem. 42. pp. 632–633, Feb., 1903. From the Physikalisch-Technische Reichsanstalt.)—In reference to the work of Bijl [see Abstract No. 521 (1903)], the author states that he has always admitted that, under certain conditions, a Weston cell containing a 14·3 per cent. cadmium amalgam is unstable. This is, however, not the case when an amalgam containing 12 or 13 per cent. of cadmium is employed. T. H. P.

1294. *Charge Carried by an Ion.* **J. J. Thomson.** (Phil. Mag. 5. pp. 346–355, March, 1903.)—A previous determination was made by the author in 1898 [see Abstract No. 1679 (1899)]. The methods adopted are the same in principle. If n = the number of positive and negative ions per c.c. of the gas, e the charge carried by an ion, u the mean velocity of the positive and negative ion in a given electric field, the current through unit area of gas is neu. The current is found by an electrometer, u was found by Zeleny and Rutherford, n is found by depositing, by Wilson's method, a cloud on the ions and determining the particles of water in unit volume of cloud. Hence e is found. Since the former paper, radium has been discovered and furnishes us with a more constant source of radiation than Röntgen rays, which were used before; also the very sensitive Dolezalek electrometer has been invented; and lastly, more exact knowledge has been obtained about the laws governing the deposition of cloud on charged ions. A table is given which shows that for small expansions (up to 1·27) only part of the negative ions are caught, for greater expansion (1·27 — 1·29) the negative ions are all caught. For still greater expansion (1·31 — 1·33) all the negative and part of the positive ions are caught, and lastly, for greater expansion (above 1·33) all the positive as well as all the negative ions are caught. This is a very important point, for the ultimate value of e ($3{\cdot}4 \times 10^{-10}$) found depends on an exact knowledge of these laws of deposition; and the value given in 1898 is nearly twice as much ($6{\cdot}5 \times 10^{-10}$), because then only the negative ions were caught, owing to the insufficient expansion used. It will be seen that if n is halved, e is doubled in the equation $i = neu$.

Two specimens of radium were used at distances 10 cms. and 15 cms. above the cloud-chamber. Other details as to the electrical apparatus, &c., used are given. The author, using the new value for e, finds a value N for the number of molecules in a c.c. of a gas at 0° C. and 760 mm. pressure. Since e is the same as the charge on a hydrogen ion in electrolysis of solution

$Ne = 1·22 \times 10^{10}$, putting in the value of δ $N = 3·6 \times 10^{19}$. This value of N has the advantage that it does not involve any assumption as to the shape or nature of a molecule, but is based entirely on experiment. P. E. S.

1295. *Spectrophotometric Study of Electrolytes in Solution.* **P. Vaillant.** (Annal. Chim. Phys. 28. pp. 213–282, Feb., 1903.)—In this investigation a Gouy spectrophotometer was used, and the absorption coefficients determined for light at certain wave-lengths with some metallic salts dissolved in water and in organic solvents. The experimental error of the observations amounts to about 10 per cent. The first experiments were made upon completely dissociated salts, namely, the permanganates of potassium, barium, and zinc, and the author completely confirms Ostwald's original observations, in that he found the absorption coefficient in different spectral regions the same for these three salts, thus showing that the colourless ion has no influence. If n be the concentration in gram-equivalents per litre, δ the degree of dissociation, and a_λ, a_λ' and b_λ the absorption due to the two ions and the undissociated molecule respectively, then the absorption coefficient for wave-length λ will be given by the equation $M_\lambda = n[\delta(a_\lambda + a_\lambda') + (1 - \delta)b_\lambda]$. Then if one ion be colourless it follows that the molecular coefficient $m_\lambda = b_\lambda - \delta(b_\lambda - a_\lambda)$, or in other words m_λ is a linear function of the dissociation. The author has examined the following copper salts: The acetate, the nitrate, sulphate, chloride, and bromide, and from his results with these and also some further observations on certain cobalt salts, he has obtained the following results: The colour of solutions in organic liquids is independent of the concentration, and is the same for all such organic solutions. In aqueous solutions, if these change colour with dilution (*e.g.*, $CuCl_2$ $CuBr_2$, &c.), the coefficient m_λ is at first a linear function of δ, but, at a particular stage of the concentration, its rate of change varies and tends to approach (when $\delta = 0$) the value obtained with the solution in organic liquids. If the colour of the aqueous solution does not change with the concentration, then the coefficient m_λ is throughout a linear function of δ. For the five copper salts the value of a_λ is the same with all for light of the same wave-length. The addition to a dilute aqueous solution of a concentrated solution of a colourless salt, having the same anion, modifies the value of m_λ and causes it to approach that of the solution in organic liquids.

The following conclusions are drawn from these results: The ions have a definite colour, quite independent of that of the parent molecule and of any others present in the solution. If a colourless electrolyte is added to a coloured one, the latter changes its colour owing to a change in the dissociation and hydration being produced. These two changes are quite independent; the first depends upon the mass of the added electrolyte and not on its nature, while the latter entirely depends on the nature of the added salt and its power to form hydrates. In solution in pure organic liquids the molecule has a fixed degree of hydration, lower, as a rule, than that in aqueous solutions. The organic solvent produces the same effect of dehydration as the added electrolyte in the case of an aqueous solution. In the case of a mixture of an organic solvent and water, the amount of hydration is governed by the dehydrating power of the solvent and by the ratio of solubilities of the salt in the water and in the organic solvent. E. C. C. B.

1296. *Residual Current in Galvanic Polarisation.* **F. G. Cottrell.** (Zeitschr. Phys. Chem. 42. pp. 385–431, Jan., 1903.)—When Ag | $AgNO_3$-solution | Ag has a current passed through it, there is polarisation and a difference in the concentration of the solution at the two electrodes. A process of diffusion then tends to equalise the potentials of the two electrodes, and in order to keep the electrodes in a fixed electrical relation (constant potential difference or constant current between them), a current must be passed continuously from without; and as the strength of this current depends on the velocity of diffusion, this velocity may be measured by this means. If a constant current be used, the resultant electromotive force may be measured from time to time; if a constant potential difference be maintained, the resultant current may be measured from time to time. The e.m.f. applied measures the concentration at the terminal, and the current measures the amount of material which reaches it per unit of time. The subject is developed historically, mathematically and experimentally from a general statement of the problem, through the relation between the e.m.f. and the concentration; the relation between concentration and diffusion; the stationary condition neglecting the potential fall in the solution, and the same taking account of this potential fall. The experimental method is based upon constant applied e.m.f., and it enables the velocity of some ions to be ascertained, even in a great excess of other electrolytes, and the velocity of zinc in an amalgamated electrode to be found. A. D.

1297. *Anodic Polarised Gold Electrodes Sensitive to Light.* **H. Kochan.** (Zeitschr. Elektrochem. 9. pp. 33–47, Jan. 8; 61–69, Jan. 15, and pp. 79–83, Jan. 22, 1903.)—The results are given of researches, made in continuation of those of Bose and the author, on the sensitiveness to light of a gold anode in an electrolyte. On separating, as far as possible, the action of light from that of heat, it is found that the oxygen retained by the gold electrode has a diminished solution voltage in the presence of light, the strongest action in this respect being exhibited by the most chemically active rays and by the violet and Röntgen rays; red, and in some cases, ultra-violet rays also have a certain action. It seems as if the influence of heat is opposed to that of light. In order to determine whether, in the action of the current, a reversible process takes place, the e.m.f. of an element and also the temperature coefficients in the light and in the dark were determined. It was found that the e.m.f of an anodic charged gold electrode towards a kathodic charged one is smaller in the dark than in the light, but that the temperature coefficient in the light is greater than in the dark, so that the process is not a reversible one. T. H. P.

REFERENCES.

1298. *Recent Advances in Electrochemistry.* **A. Coehn.** (Elektrotechn. Zeitschr. 24. pp. 244–246, March 26, 1903. Report read before the Elektrotechnisches Verein, Feb. 24, 1903.)—A popular account of electrochemical oxidation and reduction processes for the production of organic compounds, especial reference being made to the work of Tafel, Caspari and others on the influence of the nature of the electrode. T. S. P.

1299. *Aluminothermy.* **H. Goldschmidt.** (Phys. Zeitschr. 4. pp. 166–171, Dec. 1, and pp. 194–200, Dec. 15, 1902.)—Under the name aluminothermy, the author gives a clear account of the reduction of metallic oxides by means of aluminium, and of the practical utilisation of the enormous heat, produced in the process, for "sweating" metals together. D. H. J.